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The effects of policy guidance emphasizing the use of parametric methods in cost estimating

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THESIS

THE EFFECTS OF POLICY GUIDANCE EMPHASIZING THE USE OF PARAMETRIC METHODS IN COST ESTIMATING

by

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December 1996

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THE EFFECTS OF POLICY GUIDANCE EMPHASIZING THE USE OF PARAMETRIC METHODS IN COST ESTIMATING

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December 1996

ABSTRACT

This study examines the potential impacts of the DoD emphasizing the use of parametric cost estimating methods or techniques in the acquisition process. As one of many initiatives to improve the DoD acquisition process through use of commercial practices, parametric cost estimating has the potential to be helpful in many applications for which it has never before been considered. This study, conducted through a questionnaire, personal interviews and a review of recently released publications from the DoD Joint Government/Industry Initiative, identifies areas of interest for those anticipating using parametric cost estimating methods and techniques. These areas include the Program Definition & Risk Reduction and Engineering & Manufacturing Development phases of program management as well as for many pre-award contract actions. The data from this thesis show that the majority of the personnel in the DoD acquisition community believe that parametric cost estimating methods can be used effectively in those areas. The data also show that the methods also may have applications in the Production, Fielding/Deployment & Operational Support phase of program management and post-award contract actions such as negotiating changes, forward pricing rate agreements, or analyzing claims.

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I. INTRODUCTION

A. BACKGROUND

This thesis analyzes Department of Defense (DoD) Business Process Reengineering initiatives that focus on increasing the use of parametric cost estimating techniques in DoD applications. Using parametric pricing techniques to estimate program costs has a relatively short history in comparison with other pricing techniques. To date, cost estimates based on parametric estimating methods have been restricted mainly to overall initial planning but they have wider applications that are now being contemplated through direct policy action. It has been proposed that they be applied to price estimates for individual contract actions or families of contract actions to reduce a potential contractor's bid and proposal costs, proposal cycle time, and to expedite the Federal Government proposal evaluation and contract award process.

B. SCOPE AND ASSUMPTIONS

The objective of this thesis is to study the policy effects of increasing the use of parametric cost estimation methods in individual contract actions. Any reference to program management uses of parametric cost estimating methods is done to relate how individual contract actions fit within the framework of a generic program. Anticipated uses in specific programs or contract actions are not reviewed or

analyzed. No attempt is made to validate any existing parametric cost estimating models, techniques, processes, software, or their applications in specific situations.

This thesis identifies potential impediments to the implementation of the policy and makes recommendations on how they can be overcome. Specifically, the affects on proposal generation, evaluation, and subsequent contract performance is evaluated. The basic effort is directed at producing an accurate picture of how parametric cost estimating techniques may be used by the Department of Defense (DoD) and contractors throughout the contracting process until completion. Many studies have been done on the use of parametric cost estimate development for entire classes of equipments, individual contract actions, or programs, but none have focused on the affects of the policy behind the use of the methods.

It was assumed at the onset of the research that few organizations and personnel employed by DoD either directly or through a contract vehicle were trained in the use of parametric cost estimating methods. It was further assumed that of those organizations and people trained in their use, most would be concentrated at the program office level or higher in buying organizations or in the DoD policy making areas. Finally, it was assumed that neither the Federal Government as a whole nor DoD as a subset had promulgated

specific guidance, policy, or instructions regarding the use and application of parametric cost estimating techniques.

C. RESEARCH OBJECTIVE

This effort is intended to review the increased attention being paid to the area of parametric methods in the area of cost estimation in contracting. This effort will give greater insight into the potential uses for parametric cost estimating techniques. An analysis of the problems that may be encountered at the onset of policy implementation may lead to a concerted effort to meet them with corrective action before they become impediments in program management. The analysis provides information regarding how companies contracting with the Federal Government and Federal Government personnel interacting with these companies can effectively use parametric cost estimating techniques to support cost proposals submitted to the DoD.

D. RESEARCH QUESTIONS

Given the stated objectives for this thesis, the areas of research are:

Primary research question:

How could a DoD emphasis on using parametric methods in cost estimating affect the procurement process?

Subsidiary research questions include:

1. What changes could offerors make to their proposal preparation, submission, and support processes to accommodate using parametric methods, techniques, or software in estimating potential contract costs?

2. What impacts could emphasis on using cost estimates based on parametric estimating techniques have on source selection criteria and on the evaluation of proposals by the DOD?

3. How could source selection criteria and evaluation factors be constructed to fairly evaluate a proposal that uses a parametric cost estimate with one that does not?

4. What effects could using parametric cost estimations have on negotiations?

E. RESEARCH METHODOLOGY

The basis of the study is a literature review through the Defense Logistics Studies Information Exchange (DLSIE), the Defense Technical Information Center (DTIC), and various publications and journals. Data were also collected through survey questionnaires from Federal Government policy offices, acquisition management organizations, contracting offices, companies doing business with the Federal Government, and several academic institutions. The survey used is provided as Appendix C and the data from the survey are presented in

Appendix E. Personnel interviews were conducted with several representatives from DoD organizations, industry organizations, and companies doing business with the DoD. Interview questions are presented in Appendix D and the information from the interviews is incorporated in the body of the text.

F. ORGANIZATION OF THE STUDY

Chapter I of this thesis is an introduction providing a brief description of the topic, the scope of the research effort, and the research methodology used. A review of the background of parametric cost estimating is discussed in Chapter II. Cost estimation techniques and their historical uses in Department of Defense contracting are also discussed. Chapter III describes the process of developing a parametric cost estimate. In Chapter IV, the data collection methodology is described, the data displayed, and data analysis presented. Chapter V concludes the research effort with a summary of the findings, conclusions, and recommendations. Appendices will present definitions and acronyms used and the survey vehicle used to collect the data.

II. BACKGROUND REVIEW AND HISTORICAL PERSPECTIVE

A. PURPOSE

The purpose of this chapter is to lay the historical foundation from which the study was conducted. Beginning with the development of parametric cost estimating techniques, the chapter next discusses their application in the source selection segment of the Federal Government's acquisition process. Parametric cost estimating techniques are defined, as well as several other terms relating to the acquisition process, as they relate to the use of parametric cost estimating methods or techniques. Potential applications in both Federal Government acquisition and commercial arenas are examined. Finally, the chapter closes by discussing the advantages and limitations of using parametric cost estimating techniques. This information provides the background for understanding why there is an interest in applying the techniques more widely than they have been in the past.

B. BACKGROUND

1. History

Historically, the use of parametric cost estimates for pricing purposes is relatively new. Whereas price analysis is practiced in some form for every purchase that has been made, the techniques used in parametric cost estimating have

their origins in the learning curve theory espoused by T.P. Wright for use in the aircraft industry in the latter part of the 1930s. [Ref 37:p.4] The common sense notion that production of an item becomes more efficient as the quantity produced increased was finally quantified. Having this relationship mathematically derived rather than estimated through experience and guesswork, allowed manufacturers to begin forecasting requirements more accurately over several production runs. Managers could predict the cost of resources needed to produce or the delivery schedule for a given item at a given time in the production cycle through the use of a logarithmic graph of units of production and labor hours needed to produce a given unit of production. [Ref 37:p.4]

Following World War II, other estimating techniques were developed and refined. Wessel, in his article, describes several methods in use at that time to rapidly estimate project costs for use in comparative analysis of capital investment opportunities. [Ref 46:p.169] Of interest to the development of parametric cost estimating is the discussion of cost per ton of product in the U.S. chemical industry. Although this is certainly not the first time ratio analysis was used in industry, it is an indicator that the technique was in common use. Attempts were also being made at that time to increase the accuracy of the estimates through analyzing

the data and correlating costs to several production factors. At that time, the estimates were said to be accurate enough to produce results which allowed managers to narrow the choice of new products or processes to the most competitive available.

Descriptions of several common estimating techniques used by commercial industry in the late 1950s are:

> 1. Detailed Estimates are individual cost elements compiled from in-depth engineering projections.
>
> 2. Preliminary-Bill Estimates are materials priced from price lists or quotations and labor costs derived from labor-material ratios seen on similar jobs in the past.
>
> 3. Layout Estimates are equipment costs obtained from vendor quotations or price lists and then corrected for various inflation factors using appropriate indices. Material costs are estimated based on some cost per unit of output basis, with engineering costs calculated from a percentage curve based on past experience with similar projects.
>
> 4. Equipment-Ratio Estimates are estimated by using ratios developed from experience on past projects.
>
> 5. Capacity-Cost Estimates are estimates made by projecting costs for a new plant by using a logarithmic plot of similar plant capacities and costs from historical records. [Ref 14:p.131]

These techniques show increasing interest in producing accurate cost estimates and from that interest greater sophistication in generating those estimates. While there were elements of these techniques that are necessary for parametric cost estimating, they had not yet come together.

More importantly, they did lay the foundation for parametric cost estimating. To produce estimates using many of these methods the way data were collected, analyzed, displayed, and stored had to be changed.

Concurrent with the interest in the U.S. commercial industry with greater estimate accuracy, the Federal Government, particularly the DoD, was under pressure to develop more accurate estimates. As in industry, the Rand Corporation noticed relationships between costs and production outputs. [Ref 37:p.7] Whereas industrial applications related costs to production quantities or consumption of raw materials used, the Rand Corporation analyzed the correlations between costs and variables that described operating characteristics of aircraft. In particular, it was observed that certain classes of aircraft had similar cost behaviors regarding weight, speed, range, and altitude. These behaviors were called Cost Estimating Relationships (CER) and are the basis for parametric cost estimating. The combination of learning curve theory, available data from extensive production of similar items using similar processes (aircraft production during and after World War II), and development of the idea of the CER came together in the form of parametric cost estimating.

The parametric estimation methods have been used for many years with ever widening applications being found for their use. From some of the original uses in the Department of the Navy (DoN) as first order estimates relating aircraft and ship weight and cost to develop simple and fairly reliable cost estimates, the methods have been widely applied. Parametric cost estimating allowed planners to make accurate estimates of system costs at early stages in design, a solution recognized in both commercial and Federal Government applications. The Secretary of Defense (SECDEF) became convinced of the utility of Independent Parametric Cost Estimates (IPCE) in 1971 as a tool to control cost growth in major weapon systems. [Ref 25:p.12] He issued directives to use the techniques in cost estimating at the program level to solve the problem of accurately estimating Research, Development, Test and Evaluation (RDT&E) and initial production run costs. Estimation difficulties in the early stages of production at that time were exacerbated by the rapidly escalating pace of technological development. It was felt that success in the early stages of a program's life would lead to reductions in program cost overruns. In conjunction with management difficulties caused by cost overruns, there was enormous pressure to reduce the DoD budget. To manage these budgetary pressures, SECDEF hoped to have each Service perform IPCEs at

each key decision point in the weapons acquisition process to increase the accuracy of cost estimates.

Since the inception of the idea of parametric cost estimating and study by the Rand Corporation, there has been increasing application in commercial industry and the Federal Government for planning purposes. Initial uses of parametric cost estimates centered mainly on [Ref 20:p.12]

1. Identifying possible cost/performance tradeoffs in the design effort.

2. Providing a basis for cost/effectiveness reviews of performance specifications.

3. Providing information useful in the ranking of competing alternatives.

4. Suggesting a need for identifying and considering new alternatives.

The reasonably accurate estimates in the early stages of program development and widespread applicability contributed greatly to the acceptance of parametric cost estimating as a valid method. Increasing competitive forces have encouraged their use in commercial applications while high level interest and greater public scrutiny have led to wider use in DoD areas.

Figure 1 describes a general relationship between procurement cost estimating techniques used and the time line throughout a DoD-managed program. For comparison purposes,

the cost estimating techniques used before the advent of parametric cost estimating are shown along the base of the figure where they might have been used at various times during the program life. Parametric cost estimates are used in all phases of a program life cycle but are most often the basis of estimates in the Program Definition and Risk Reduction (PD&RR)(Phase I) of a program life cycle. [Ref 26:p.21] Parametric cost estimating is perceived as the best method of generating a detailed estimate from the available data when only mission and performance parameters have been described. [Ref 23:p.291]

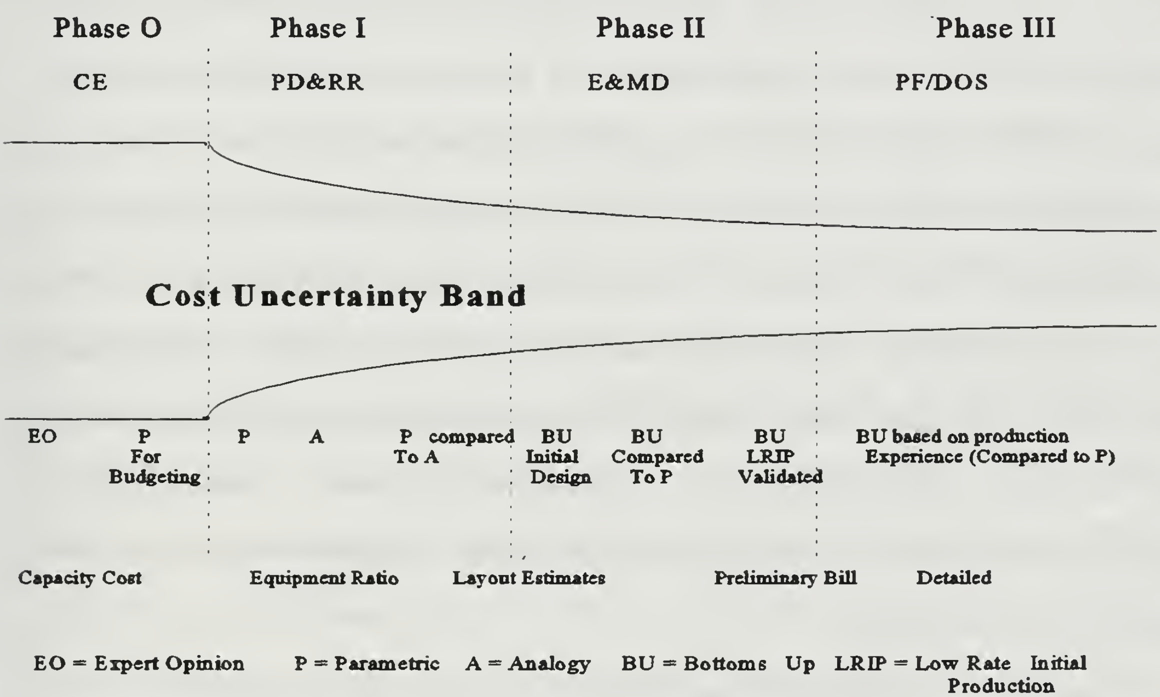


Figure 1: Program Phases and Types of Estimates

Source: Refs 22, 25, and 33

From its inception, parametric cost estimating has experienced an ever expanding base of uses. Aircraft programs have long been the beneficiaries of parametric price estimating techniques. Weight has been the primary independent variable to parametrically estimate costs for aircraft systems. Analysis by the Rand Corporation showed that another useful variable that shows a good correlation to cost is speed. [Ref 20:p.21] Other analyses have defined a parametric relationship between cost and wetted area, aspect ratio, number of engineering drawings, number of parts, and even time in aircraft development and production programs. [Ref 20:p.34] Despite all of the analysis, weight is the most consistent and accurate parameter to estimate aircraft program costs. [Ref 20:p.36] No longer applied solely to Federal Government aviation programs, the techniques have been used in a wide variety of Federal Government areas. Projects in the Federal Government that have used parametric cost estimating techniques include Department of Energy construction of dams and mining structures. Commercial uses range from construction and aircraft manufacturing to computer software generation projects.

The DoN is heavily dependent on the use of parametric pricing for major systems planning. It forms a major part of shipbuilding and aircraft cost estimating both at the

aggregate level (program) and equipment level. The techniques are used in projections in shipbuilding to estimate costs within each element of the Expanded Ship Work Breakdown Structure. Similar to the CERs observed from aircraft production, one of the most useful correlations is that of a ship's gross tonnage to cost. [Ref 35:p.23] One of a ship class's most consistent physical aspects that shows a useful correlation to cost is that of gross tonnage, making it a most useful variable in ship cost estimation. Other CERs that have been developed and used successfully for shipbuilding estimates are man-hours to gross tonnage and power rating ratios to gross tonnage relationships. [Ref 35:p.37]

The development and use of parametric cost estimating has followed that of the development of computing capability. Prior to the widespread availability and use of computers, data collection and analysis on the scale required for parametric cost estimating was prohibitively expensive and time consuming. As computer hardware improved so has the use of parametric cost estimating. Software has also made tremendous improvements that parallel those of hardware. More sophisticated processing of data and user friendly programs have combined with the hardware improvements to bring parametric cost estimating into common use. These capabilities allow quantitative analysis of such accumulations

of data that, without the computer, parametric cost analysis would not be useful in terms of timeliness even if it were possible at all in a manual environment.

2. Source Selection Process Development

Parametric cost estimating occupies an important niche in the source selection process. For the contractor proposing to do business with the Federal Government, estimate accuracy could mean the difference between winning and losing the award of the contract. A contractor who uses a poor estimate in a Firm Fixed-Price (FFP) contract environment will suffer by using that estimate. He will either lose money through underbidding his costs if he bids lower than his actual costs and wins the contract award, or he will lose business if his estimate is too high, he bids too high, and he is not awarded the contract. For the Federal Government, a reliance on a low estimate could lead to quality control problems. The contractor who won the contract with a low bid will attempt to limit his loss through contractor cost cutting measures. In a Cost-Reimbursement contract environment, additional management resources will be required of the Government to control cost overrun situations. The increased costs will also bring greater public scrutiny on both the Government and the contractor as cost overruns develop. In either case, inaccurate cost estimates damage the competitive industrial

base and have adverse impacts on the Federal Government procurement process.

Along with the greater computing capacity, the growth of parametric cost estimating depended on the data that were available for analysis. Other Federal Government applications depended on the collection of data for analysis. This data collection was made available in large part through dependence on detailed engineering cost and schedule estimates. The Truth in Negotiations Act of 1962 (TINA) codified cost and pricing data requirements that were to be submitted in contract negotiations with the Federal Government. In meeting these requirements with detailed cost estimates, commercial industry built the databases required for effective parametric cost estimating.

Cost Accounting Standards (CAS) has also had a significant impact on the use of parametric cost estimating methods. One of the basic premises of CAS is consistency in estimating, accumulating and reporting costs by a company proposing to do business with the Federal Government. Any parametric model used by a company must be able to segregate estimates of costs to match the data collection system used in that company. This in turn should match the proposed work breakdown structure (WBS) upon which understanding of the contractor's ability to perform work delineated in the

Statement of Work (SOW) depends. Failures in this area could make it difficult for a buying organization, the Defense Contract Audit Agency (DCAA), or the Defense Contract Management Command (DCMC) to evaluate a company's cost proposal. Differences here could also result in CAS violations which in turn could lead to adverse effects on prior performance ratings.

Cost estimating plays a major part of any procurement decision from influencing the budgetary processes to final source selection. The Competition in Contracting Act (CICA) of 1984 followed TINA, and both had tremendous impacts on the source selection process in Federal Government procurement. Where TINA determined data to be submitted as the basis for a cost proposal, CICA clearly allowed for negotiated procedures in a competitive environment for Federal Government procurement when sealed bidding conditions do not apply. [Ref 41] Beyond the FAR and Defense Federal Acquisition Regulation Supplement (DFARS) guidance, executive agencies have published additional regulatory constraints that affect the conduct of Federal Government procurement actions. General guidance is given, however, in the DCAA Contract Audit Manual. [Ref 37:Appendix C] Parametric cost estimating techniques are not specified for use or directed to be used in any of this guidance; rather their use has grown as a sensible,

businesslike answer to meet the needs of individual programs and procurement actions. [Ref 37:p.7,198]

In acquisition planning, specified in CICA and depicted in Figure 1, parametric cost estimating is applied to provide a manager with useful data upon which he can make an informed decision. Source selection planning for a particular procurement is only a part of the overall plan, but it is the place where the uses of parametric cost estimating are best illustrated. An individual procurement action using parametric cost estimating can occur in any of the four phases shown in Figure 1. Determining that parametric cost estimating is useful in the conduct of a procurement action may have the most beneficial outcome when used in the planning stages. Parametric cost estimating considerations can best be integrated into procurement planning to fully exploit their potential.

Use of parametric cost estimating techniques could first impact the individual procurement by affecting the structure of the solicitation for an item or service. The buying activity may choose to construct the solicitation to accept, reject or encourage the use of parametric cost estimates. Requiring the use of parametric cost estimating techniques may in some instances restrict competition to those with the experience in not only providing the goods or services

required but also knowledge and experience with the techniques specified. Rejecting the use of parametric cost estimating techniques as valid methods of supporting a price proposal could remove a competitive advantage for a company in another situation.

From the solicitation, the companies submitting proposals will construct their proposals in a way to present their company as the best value for the buying organization. They will present the data required by the solicitation in support of their proposal. For those companies familiar with parametric cost estimating techniques, this could be a direct competitive advantage. Conversely, for those who are not familiar with them it could be an administrative burden at best and a liability in the competitive environment if they are required by the buying agency. The buying organization should recognize the differences in how parametric cost estimates are developed from the traditional bottoms up estimates and structure the support data requirements accordingly. In either situation, the buying organization should restrict the data to be submitted to only those required to support analysis of the proposal.

The evaluation criteria for the procurement, expressed in the solicitation, should drive the data collection efforts. These criteria are required to be explained in the body of the

solicitation to potential offerors. Companies proposing to do business with the Federal Government will use these criteria as considerations in the construction of their proposal. Each buying organization may have a different view of the interrelationships between the elements in the evaluation criteria. Parametric cost estimating could have impacts not only in the area of cost comparisons and cost realism but also in the technical proposal involving understanding the requirement. In the evaluation of management capability, parametric cost estimating could again demonstrate a company's level of understanding of the requirement as well as affect a company's score on past performance.

The proliferation of data collection systems, management systems, and user friendly statistical analysis programs make the techniques of parametric cost estimating more available than ever before. The techniques have generated an industry whose goal is to provide parametric estimating services and tools to potential users. The DoD-maintained Constructive Cost Model (COCOMO) was developed to estimate software cost estimates. One of the more widely used parametric cost estimating models produced by commercial industry is the Programmed Review of Information for Costing and Evaluation (PRICE). [Ref 37:p.219] The PRICE model was initially developed by the RCA Corporation in 1974 to provide

engineering and manufacturing costs for equipment having a wide range of applications. It has undergone several enhancements since its inception and is now a family of cost estimating models for hardware and software projects. [Ref 21:p.145] PRICE, however, is only one of many models developed by industry and the Federal Government to meet the needs of program and procurement management.

The development of parametric cost estimating has progressed along with increasing budgetary pressures, and technical and management improvements. The current state of the art in all of these areas has brought renewed interest in their use by the upper echelons of DoD. As a step beyond their earlier uses, the present drive is focused on reduction of contractor costs from onerous Federal Government reporting requirements and an intense desire to reduce equipment development cycle times.

> One way to reduce the burden associated with providing cost and pricing data is to permit greater use of parametric estimating techniques. Properly calibrated parametric techniques can accurately estimate costs while reducing bid and proposal costs and proposal cycle time and expediting the Government evaluation process.[Ref. 42:p.1]

To reach the goal set out in the above memorandum by the Under Secretary of Defense, the use of parametric pricing will have to become more widely accepted throughout the DoD

acquisition community as a cost estimation tool rather than viewed as a program management tool for cost estimates.

C. DEFINITIONS AND CONCEPTS

1. Parametric Cost Estimating

Parametric cost estimating involves the collection and organization of historical information, analysis through mathematical techniques, and relating this information to the work output that is being estimated. A parametric cost estimate can be defined as an estimate which predicts cost by means of explanatory variables such as performance characteristics, physical characteristics, and characteristics relevant to the development process, as derived from experience on logically related systems. [Ref 37:p.172, 22:p.293] Combinations of CERs and their relationships are used to describe the likely cost behavior of a project. The emphasis in parametric cost estimating is to "focus on the cost drivers, not the miscellaneous details" [Ref 37:p.11] that are common in other cost estimating techniques.

2. Parametric Cost Model

A parametric cost model is simply the group of CERs and logical relationships used together to produce cost estimates. They can range from common rules of thumb, such as costs per gallon, to elaborate computer models. [Ref 17:p.12] A parametric cost model is one derived from the relationships

between data points in a historical database used to provide a top down cost estimate. The buyer is attempting to relate what he or she wants to buy in units of capability to the cost for it. This is a departure from the traditional industrial engineering (or bottoms up) approach of describing what a buyer is paying for through the use of detailed cost accumulation systems.

Parametric price analysis is used at all stages of a major procurement from the initial estimates to developing estimates for costs for components later in production. Figure 1 is a representation of how parametric pricing is typically used in comparison with other cost estimating methods.

3. Cost Estimating Relationships

The CER is the key component in the development of a parametric cost estimating model. CERs are described as:

> ...an algorithm relating the cost of an element to physical or functional characteristics of that cost element or a separate cost element; or relating the cost of one cost element to the cost of another cost element. [Ref 37:p.165]

This idea is rooted in the fact that costs in the production of an item are related in a quantifiable manner to its physical or performance characteristics. An example of this principle in the Contract Pricing Resource Guides (CPRG)

describes the procedure of developing a CER for building houses and relating the costs to such variables as the number of bathrooms, available living area, exterior wall surface, or roof surface area. [Ref 1:p.D-31]

CERs can be broken down into two categories, cost-to-cost (overhead rates) and cost to non-cost (cost per pound of thrust). It is critical that the cost analyst understand the logical relationship between cost and any independent variable for the model to be used effectively. This understanding leads to knowing the limits of the model and potential effects of using it with a new database.

4. Mathematical Techniques Used in CER Development

Regression analysis and multiple regression analysis are two statistical techniques that can be used to relate the cost (dependent variable) to a characteristic (independent variable). [Ref 23:p.291] The aim of regression analysis, in the form of applying linear, curvilinear, logarithmic, or exponential techniques to the data, is to derive the equation of a curve that predicts how an independent variable will vary with respect to a given parameter or dependent variable. In the case of procurement, interest has been focused on the cost and schedule estimating aspects. When the parametric relationship has been described, it can be used to estimate

system costs by substituting different cost, performance, or other characteristics into the equation.

A second mathematical method that can be used to derive a CER is the Least Squares Best Fit (LSBF) method. [Ref 37:p.41] This algebraic method minimizes the sum of the squared deviations of the observed values of a variable and calculated values of that variable. In this method, a series of calculations involving the mean values of the dependent and independent values and the point-slope formula are used to arrive at a formula that describes the CER between the two variables.

Apart from strict mathematical derivation of the relationships between two variables, plotting a series of data points and graphically determining the line of "best fit" can also be used to derive a CER. [Ref 37:p.41] This method requires plotting the data points and simply drawing a line through the data points leaving an equal number of points on either side of the line. The drawn line must follow the general trend of the data points and every data point must be considered. Any outlying data points must not be discarded but instead investigated to understand why the variation in the data occurred. The point-slope algebraic formula for a line can be used to derive the CER in this method if a linear

relationship is noted. Curvilinear regression is another method available to develop the CER.

5. Statistical Measures of Accuracy

The statistical measures of the accuracy of an estimate based on the two described mathematical methods can be described in terms of:

1. The Standard Error of the Estimate (SSE) - the variance associated with the prediction made from the estimating equation. [Ref 25:p.13]

2. The Coefficient of Determination - the closeness of fit between two variables or how much one factor is affected by another. [Ref 37:p.46]

With these measures, a manager has another tool to assess the applicability of the CER to a given program or system. Using regression analysis, the data are then analyzed for relationships. The smaller the SSE and the larger the Coefficient of Determination the more accurate the equation will estimate the costs that will be incurred. Examination of the estimates made by the equations over the data range is a critical step in the evaluation. Often there are breaks or discontinuities observed in the data. At these points the relationship between one independent variable and the dependent variable breaks down and another relationship between the dependent variable and a second independent

variable becomes a more reliable predictor. There may be several CERs for a given item or system depending on the level of production or range of a given performance characteristic.

6. Model Validity

Comparability between the items or services upon which the database is founded and those to be estimated is an idea even more basic to parametric cost estimating than the CER. Hertling defines parametric cost estimating model validation as "the process of determining that a model is a reliable predictor of costs for the type of system being estimated." [Ref 17:p.13] This is also an issue in the analog method of cost estimating. Analog cost estimating methods are simply comparisons between past costs observed on similar types of systems or equipments and new ones. Although there may be some difficulty in determining what are logically related systems or programs that can be compared, the techniques can be easily applied if such a relationship can be defined between an existing system or program and a projected one. As in the analog methods of cost estimating, the greater the difference between the programs, systems, or equipments that make up the database and the projected system, the less useful is the estimate produced.

The validity of the historical data analyzed is one of the most important factors in its later applications. [Ref

37:p.12] Data input to the model must be verifiable and accessible to the cost estimator. Data accuracy is critical and has more dimensions than just similarity between the old and new programs, systems, or equipments. Parametric cost estimates are least useful where there are few data points for development of the basis for the CERs or when the methods of performing a task change significantly. The comparability between a new system and existing ones whose costs make up the database used affect the model's accuracy. Accuracy increases when the methods used for production of like items or systems are very similar. An example of this is a system that has undergone upgrades, with the new item or system incorporating technological innovations or increased performance characteristics beyond those previously attained. [Ref 23:p.293]

7. Model Validation and Calibration

One method of validating a parametric cost estimating model involves generating estimates with the model for comparison with actual costs incurred. [Ref 37:pp.18, 176] The differences must be explained and understood for the model to be useful. Without that understanding, the model must be modified and analyzed until it does produce reliable and accurate estimates.

Calibration of a model is basically the relation of a model to a particular instance rather than a general set of events. This would be a consideration in cases where a company uses a standard commercial version of a software product or model for estimate generation rather than a company that developed a model based on their own historical data. [Ref 37:pp.17, 162]

8. Work Breakdown Structure

In the Federal Government acquisition process, the WBS is often used as a base upon which the technical requirements for a program, system, piece of equipment, or individual contract action are developed. [Ref 37:p.177] Through a hierarchical family tree structure detailing the end product, work elements to achieve production of the end product, and their relationships, an understanding of the processes involved in the accomplishment of an objective is achieved. Specifically:

> ...the work breakdown structure plays a significant role in planning and assigning management and technical responsibilities; and monitoring and controlling the progress and status of (a) engineering efforts, (b)resource allocations, (c) cost estimates, (d) expenditures, and (e) cost and technical performance. [Ref 37:p.178]

Guidance regarding the use of the WBS is provided in MIL-HDBK-881. [Ref 37:p.177] DoD policy is that MIL-HDBK-881B should be referenced for guidance only in appropriate solicitations

defined as those solicitations involving cost risk to the Government. The intent is to improve program and contract WBS development, provide guidance to the contractor in extending the program WBS and maintain the integrity of the WBS.

9. Price and Cost Analysis

Price and cost analysis are used to determine that fair and reasonable prices are paid for products in business as well as Federal Government procurement. [Ref 2:pp.253, 262] Price analysis acts to keep a focus on the value of an item, and parametric cost analysis with its focus on cost drivers is a clear application of that principle. Price analysis allows a buyer to compare a price against a standard as a yardstick to determine if an item is worth the cost. Price analysis techniques are generally faster and do not cost as much to perform as cost analysis, a detailed breakdown of costs for each cost element in a proposal, but price analysis cannot give an accurate picture of what will be paid for an item in all cases. Price analysis is principally performed using these four methods [Ref 2:p.253]:

1. An analysis of competitive price proposals is conducted.

2. A comparison with regulated, catalog, or market prices is performed.

3. A comparison with historical prices is performed.

4. An independent cost estimate is used.

Price analysis only provides estimates of those costs relative to the accuracy of the prediction. It does not provide exact price predictions about costs that will be incurred in an effort.

Parametric cost estimating ties together the concepts of price analysis and cost analysis. It is one of the methods of comparing a price in the present with those historically paid for an item and is one of the four methods a buyer has available to perform price analysis. Parametric cost estimating combines the price analysis technique of referencing historical prices with the mathematical analysis inherent in improvement curve theory from cost analysis. [Ref. 2:p.267]

10. Cost Realism

Cost realism is a key concept in the source selection process entailing understanding a cost proposal in detail and evaluating the accuracy of component costs. The purpose of cost realism is to give a source selection official greater assurance that the effort will cost what is estimated in the proposal when the work is complete. [Ref 6:p.3-1] The inference is that the more realistic the proposal the more likely the project will avoid a cost overrun situation. Specific information about how a cost proposal will be

evaluated should be included in the source selection evaluation plan for a given procurement action and published in applicable solicitation documents. In general, the Federal Government will assess cost realism based on the difference between the contract offer and an Independent Government Cost Estimate (IGCE). Another method of determining cost realism is to compare the proposed costs with a recalculation of the costs by the buying command based on contractor-provided data, past performance, and information from DCAA or DCMC audits. [Ref 6:p.11-3]

D. PARAMETRIC COST ESTIMATING APPLICATIONS IN ACQUISITION

From the original efforts made by the Rand Corporation to develop a method of accurately estimating costs of proposed new systems, the uses of parametric cost estimating have expanded. Parametric cost estimates have been and continue to be used to [Ref 37:p.71]

1. Identify possible cost-performance tradeoffs
2. Provide a basis for cost/effectiveness review of performance specifications
3. Provide information useful in ranking competing alternatives
4. Identify and consider new alternatives
5. Develop target cost estimates for planning purposes
6. Estimate new program costs

7. Make decisions during bid or proposal strategizing

8. Cross check actual costs during program life cycle with projected cost estimates made during planning.

All of these uses have been primarily in the program management area. In the later stages of a program, they are used in a secondary role to bottoms up estimating. In fact, the CPRG has the use of CERs in price analysis shown as a secondary comparison technique. Emphasis is now on using parametric cost estimates as a primary source of cost estimates on an individual contract action basis. The primary goal is to maximize efficiency and minimize complexity of the solicitation, the evaluation, and the selection decision process.

E. ADVANTAGES OF AND LIMITATIONS IN USING PARAMETRIC COST ESTIMATING TECHNIQUES

1. Advantages

Parametric pricing using CERs has the advantages of being quick and simple to apply once the relationship has been described adequately. [Ref 37:p.38] This is a result of the reduced need for cost data specific to the cost elements of the new item or system. The only data needed are the independent variable inputs to the equations to get an output. Efforts normally used to generate detailed cost estimates, that may be no more accurate than the parametric estimates,

can be allocated to other more profitable endeavors. Where a detailed estimate may not be possible because of the lack of data, a parametric cost estimate may be possible.

Parametric cost estimating methods do not have to be isolated to use only in large scale applications at the program or even entire equipment level. [Ref 37:p.68] They can be applied at the component level for inclusion in another type of cost estimate as well as on the macro management level. They provide a relatively quick and accurate way to produce cost estimates on a program or system level to be used as a sanity check. On the larger scale, when used to estimate costs at the system or program level, the data base includes costs incurred as a result of setbacks or other problems. With the database built on a continuing series of changes, usually in high technology areas, the model takes advancing technology automatically into account. Thus the CERs have a built-in correction factor for problem areas often observed as well as for program cost escalations and inflationary pressures.

The accuracy of parametric cost estimates has improved significantly since their inception. [Ref 25:p.5] Using proven databases parametric cost estimating models are outstanding predictors of accurate estimates. From order of magnitude estimates in the early chemical industry

applications, to being equally as accurate as detailed engineering cost estimates in 1975 [Ref 25:p.6], the accuracy of parametric cost estimates has improved to the present claims of five percent difference from actual observed costs in some uses of the PRICE models. [Ref 21:p.147] As in any modeling situation, accuracy of the inputs is a critical factor in obtaining useful and accurate output data. Parametric cost estimate accuracy is highly dependent on the following variables [Ref 14:p.129]:

1. Degree of project definition
2. Comparability between projects in the database and the proposed project
3. Status of model calibration and validation
4. Data availability and depth of the database used
5. Adjustments made to the data to ensure comparability within the database

Another factor to consider is the increasing accuracy levels achievable throughout the life of a project. As more is known about a project, more accurate estimates can be made over time. The benefit of a parametric cost estimating system is the speed at which revised estimates can be generated as new information becomes available. The flexibility inherent in the parametric cost estimating methods is also demonstrated in their uses in conducting "what if" analyses.

2. Limitations

Despite all of the advantages, there are some difficulties with using parametric cost estimating methods. They may not be applicable in all cases because one may not be able to find a close relationship between costs and any independent variable that can be easily measured or quantified. In some cases the models use CERs that do not provide sufficient detail to accurately predict costs. To maintain accuracy, the historical data base must be updated continuously, or the equations may not accurately represent the relationship between costs and the independent variable chosen as a basis for estimation. Technological changes in manufacturing processes, to the equipment itself, or significant changes in the management structure of an organization may make it to difficult to compare and correlate with the established database. [Ref 14:p.130]

Additionally, several problems distort the results from parametric price estimation. Aside from inaccuracies that can be introduced by design into the equations to allow greater applicability, the size of the data base can have dramatic effects on the accuracy of estimates. [Ref 14:p.132] Larger data bases will generally have greater accuracies than smaller ones as the statistical models increase in accuracy. Data point dispersion will also affect the accuracy but this can be

measured through the use of SSE and coefficient of determination values. The standardization and normalization of data that is required to be able to compare the results across programs can also adversely affect the output of a parametric cost estimating model.

Two such areas of normalization are in the adjustments for inflation by Price Level Adjustments and Cost to Quantity Adjustments. [Ref 16:p.120] The data to be analyzed must be adjusted to a base year constant dollar level for comparison purposes through the use of standard indices. To compare across different procurement sizes in terms of quantities of units purchased, the data used in analysis must also be adjusted to develop consistent cost measures. The most common method used to do this is through the use of learning curve and average cost per unit calculations and techniques. [Ref 37:p.19]

As accurate as parametric cost estimating is, it cannot give a 100% accurate picture of what will be paid for an item. The nature of estimating is to predict costs in the future based on extrapolating known data forward in a new situation. The only way to obtain 100% accuracy is to have full visibility of costs throughout the life of the project and total them at project completion.

Development of a parametric cost estimating model and its maintenance is expensive. Database management itself is costly as is maintaining a system of data collection to build and update the information required to keep a parametric cost estimating model up to date. Without constant maintenance, CERs and the model that is based on them can fall out of date rapidly. Finally, although parametric cost estimating models are very flexible within the boundaries in which they were derived, the degree of difficulty in redefining those boundaries makes them inflexible in accommodating major program changes.

F. SUMMARY

Parametric cost estimating has enjoyed a long history and it is used in numerous applications. The foundation of parametric estimating system is the integrity of the historical database and the CERs that make up the model. Before any parametric model is used, the model and database must be examined to ensure that they are up to date and accurate. The model should be calibrated for a specific situation and then validated before it is relied upon. With this information as a base, the following chapter will use the concepts addressed in this chapter to develop a cost estimating model using parametric methods.

III. DEVELOPING A PARAMETRIC COST ESTIMATING MODEL

A. PURPOSE

This chapter will describe a process by which a parametric cost estimating model might be developed. Knowing how a model was developed allows the user to understand the strengths and limitations of the model. This in turn will lead the user in the most beneficial application of the model to the data available or give him the knowledge he will need to optimize the model to meet his specific needs.

There are eight basic steps in the construction of a parametric cost estimating model. [Ref 25:pp.8-35]

1. Gather data on both costs and potential independent variables such as speed, weight, or number of lines of computer code.

2. Plot the data. Through a simple visual analysis, the user may determine that there is no useful correlation between cost and the independent variable.

3. Mathematically or graphically relate the data points is the process of CER formulation.

4. Examine the CER. Does the CER logically apply to the data?

5. Refine the CER and review the data.

6. Test the CER. Does the CER predict costs comparably to known historical costs for the variables used in the CER?

7. Combine the CERs in the Parametric Cost Estimating Model.

8. Test the Parametric Cost Estimating Model. Does the model predict costs comparably to known historical costs?

For the purposes of this effort in model construction, a study by Raymond E. Moore III in 1975, Cost Estimating Relationships For Naval Surface Ship Electronic Warfare Equipment, will form the basis. [Ref 25] In that study, Moore developed a parametric cost estimating model for electronic equipment based on a review of the costs and technical data for 12 existing systems. These data are shown in Table 1.

Table 1
Electronic Warfare Equipment Data Matrix

System	Unit Cost	Year	Development Cost	Installation Cost	Weight	Volume	Sensitivity	Power Usage	Quantity	Gain
SLQ-19	758	69	1886	268.1	5190	275.2	-35	15.0	4	0
SLQ-26	1572	70	3654	582.5	6016	262.1	-36	15.0	8	15
SLQ-28	4092	71	11694	562.5	21032	560.7	-20	15.0	5	15
WLR-11	120	72	360	245.3	375	16	-65		12	0
SLQ-30	408	74	1600	37.0	2060	131.6	-45	1.0	100	15
SLQ-12	250	65	1754	52.1	2614	154.2	-50	.4	50	20
SLQ-17	1625	73	7256	168.9	6000	450	-48	15.0	30	15
SLR-12	6.8	65	380	15	200	12	-60		315	18
WLR-1	30.0	63	3598	280.1	1958	185	-80		600	15
WLR-3	3.0	63	45		25	1	-45		400	15
WLR-8	1200	73	11694		2908	220	-85		7	15

Source: Reference 24, p. 40

B. PLOTTING DATA

Moore compiled these data and analyzed the relationships between both development and installation costs and all of the parameters listed in Table 1. [Ref 25:pp.11-21] For illustration purposes, this study will demonstrate the second step in the development cycle by plotting the system weight against the development costs in Figure 2.

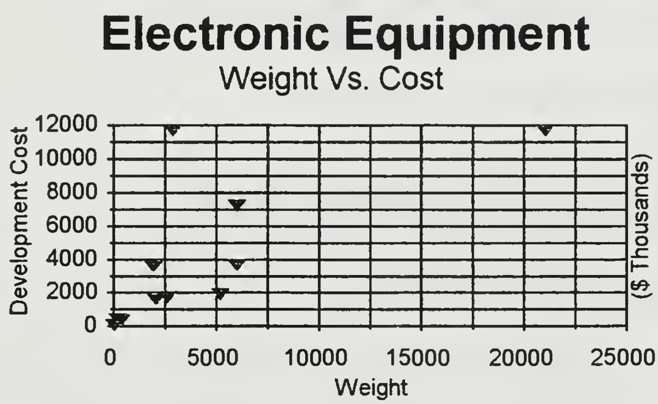


Figure 2: Weight/Cost Data Plotted Graphically

Source: Developed by researcher.

At this point, a visual inspection shows that although there are some outlying data points, it appears as if a useful mathematical relationship can be derived from the points. In contrast, Figure 3 is a graph of system development costs plotted against quantities of the systems acquired. From visual inspection of the graph there appears to be no useful correlation between these two variables.

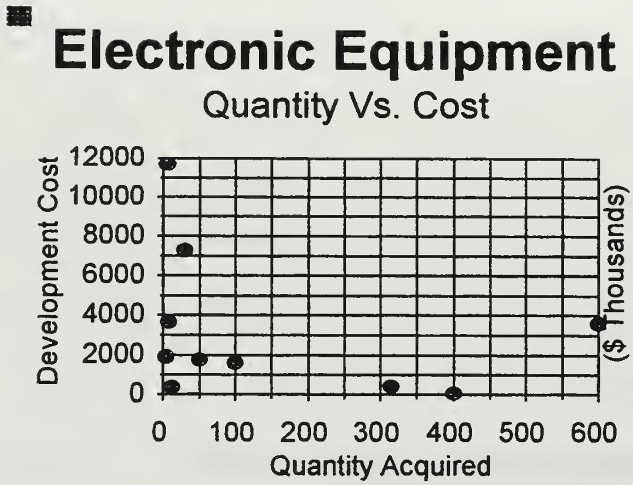


Figure 3: Quantity/Cost Plotted Graphically

Source: Developed by researcher.

To develop a CER to be used in parametric estimation, the buyer has to first decide what he wants to estimate (cost, schedule, material, labor, or some other parameter) and then determine how the variables are related in the work to be performed. Will the price estimate be derived directly from the data or tied to a variable to which a cost is then applied? Here, it has been determined that cost will be the dependent variable to be derived directly from the independent variable, weight.

C. CER DEVELOPMENT

Having selected the characteristic that will give an accurate representation of the relationship between the independent and dependent variables, the relationship must be quantified. The independent and dependent variables must be not only related in some manner, but they must be related in a definable way. There has to be an understandable relationship between the data points, and the data points must be easily measurable or inferred from available data.

Using linear regression techniques a line can be used to approximate the relationship between the data points. Here the relationship between development cost and weight can be described as Y= (.950082 x System Weight) + 604.4864. This CER is shown in Figure 4.

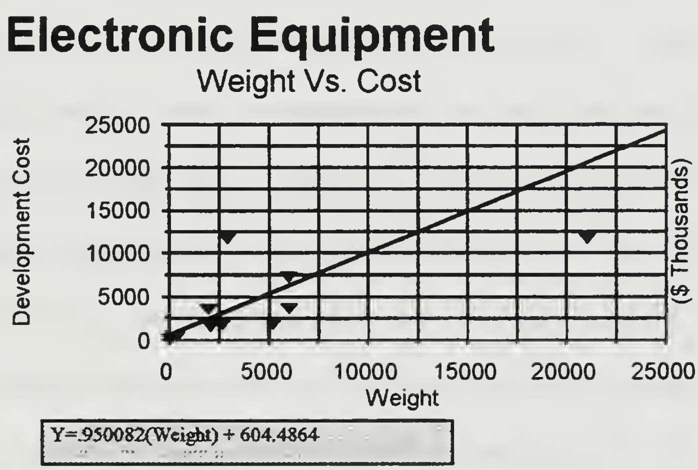


Figure 4: Cost/Weight CER Overlaid on Data Graph

Source: Developed by researcher.

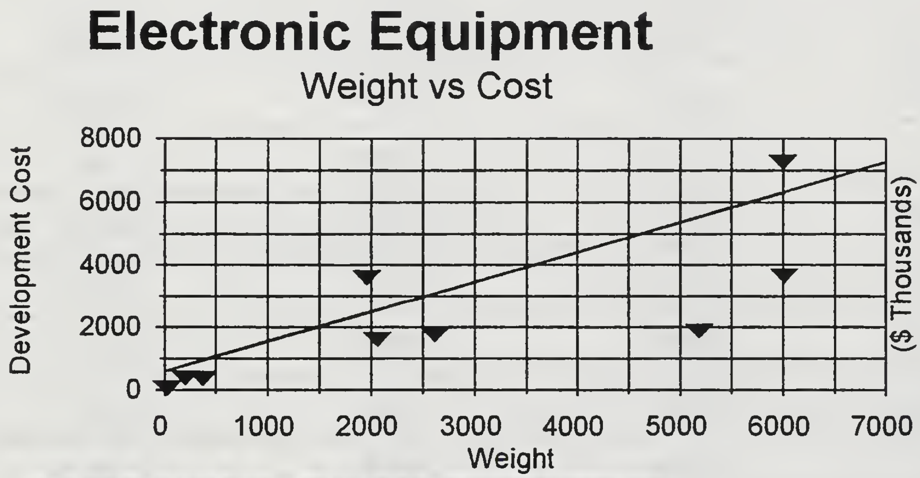
The coefficient of determination for this CER is calculated to be .691395 and the SSE to be 4519.926. A coefficient of determination with a value of 1.0 indicates a perfect correlation between the two variables. In this case, for illustration purposes, the coefficient of determination is close enough to a value of 1 to be useful as an indicator of future costs. The SSE is relatively large, in part due to the wide range of development cost values used in the computation and the small database used.

D. COST ESTIMATING RELATIONSHIP REVIEW/REFINEMENT

A test of the CER developed here shows that it does make intuitive sense. As one would expect, costs appear to rise as the weight of the system increases. An examination of the relationship and the data supporting it are now made in an attempt to increase the accuracy of the CER. Should some of the outlying data points be discarded and is the mathematics used logically sound are two questions that have to be answered each time the CER is used. As an illustration to show the effects of data manipulation, two data points will be discarded and the results shown graphically in Figure 5.

Deleting the two data points from the database has a great effect on the interpretation of the information. The CER developed has changed to Y= .834494 (Weight) + 1300.296 with a coefficient of determination of .777718 and a SSE of

1643.74. While this action has increased the accuracy of the CER, it may have also reduced the effective range over which it is valid. Any use of the two CERs developed must take these data manipulations into account.



Y= 834494(Weight) + 1300.296

Figure 5: Revised Data and CER

Source: Developed by researcher.

E. COMBINING CERS INTO PARAMETRIC COST ESTIMATING MODELS

Concluding the data manipulation and CER refinement initiates the final step in the process of CER development. In this construction, historical costs are compared with costs that would be projected by the CER using the known weights for the system. Table 2 presents those data for review. Here, it will be assumed that the CER data compares favorably with the

historical data and that they fall within an acceptable range for estimating costs.

Table 2
Actual vs. CER Projected Costs

System	Weight	Development Cost	CER Projected Cost
SLQ-19	5190	1886	5535
SLQ-26	6016	3654	6320
WLR-11	375	360	961
SLQ-30	2060	1600	2562
SLQ-12	2614	1754	3088
SLQ-17	6000	7256	6305
SLR-12	200	380	795
WLR-1	1958	3598	2465
WLR-3	25	45	628

Source: Developed by researcher.

Up to this point, the construction has been concerned with developing a single CER for estimating development costs. The purpose of the effort, however, is to derive a parametric cost estimating model for a new electronic system. Development costs comprise only a part of the costs of any system. Other costs that might be considered are installation costs, spare parts, and training for operators. To build a parametric cost estimating model, all of these factors must be combined in some form. They may be estimated using a CER, as were the development costs, or by any of the other cost

estimating techniques available. A parametric cost estimating model considering these and other factors developed by Moore for this data set can be described by the following equation [Ref 23:p.21]:

PROC = 2811.59351 + .05553 (DEVC) + .02824 (Weight) + 3.81016 (Volume) + 25.98703 (Sensitivity) + 73.68718 (Power Usage) + 77.15399 (Gain) - 1667.51343 (ACT) - 1027.33765 (LG) - 1718.32324 (SM)

which had the following statistics:
Coefficient of Determination= .9997
Standard Error of the Estimate =65.119

where:

PROC - Procurement Cost

DEVC - Development Cost

ACT - Active Equipment Code

LG - Large Vessel Code

SM - Small Vessel Code

With the parametric cost estimating model complete, there is only testing against historical costs to verify the accuracy of the model remaining. The process described above is illustrative of one method available to develop a parametric cost estimating model. Using the parametric cost estimating model developed, the methods can be used in any of a program's life cycle stages for any number of estimating purposes.

F. SUMMARY

This chapter developed a CER using regression analysis to demonstrate the relationship between the database used and the basis for the estimate. From this and other CERs particular to the equipment that is to be developed, a model would be constructed. This model would then be calibrated if that action was required and finally validated. After that point, it could be used to estimate the costs of electronic systems of a similar nature to the ones that made up the database. The next chapter describes the data collection and analysis of the data from surveys and interviews.

IV. METHODOLOGY AND DEMOGRAPHICS

A. PURPOSE

This chapter will discuss the data collection methods used in the study. Construction of the survey vehicle, Appendix C, and interview questionnaire, Appendix D, will be described followed by a discussion of the methods used to disseminate the survey. Data in this chapter will be presented as aggregate information describing the demographic breakdown of the respondents.

B. DATA COLLECTION

Data collection was centered around the primary and secondary research questions. Information regarding the area of interest was collected throughout the use of a self-administering survey and personal interviews. The research questions formed the backbone of the survey, breaking the survey into discrete areas of interest. The survey was structured to follow a possible pattern of use for parametric cost estimating techniques through an acquisition cycle. Each major question is broken into several subsets to allow greater analysis of the topic in question.

Questions one through four form the basis of the discussion of the use of parametric cost estimating in the procurement process. Ascertaining the risks inherent in the

program, system or equipment, its similarity to existing efforts, and the development of the databases available for analysis are key elements in determining how parametric cost estimating can be used in acquisition planning. Questions one through four represent some of the management areas to which parametric cost estimating have been and can be applied within the acquisition cycle.

From the basis formed by questions one through four, the survey moves on to obtain opinions regarding the subsidiary research question: What changes will offerors make to their proposal preparation, submission, and support processes to accommodate parametric methods in estimating contract costs? Question five transitions from the general uses of parametric cost estimating methods to issues specific to the conduct of pre-award contract actions. Question seven continues to gather opinions regarding the question of offeror proposal preparation. The buyer's estimation of his position regarding the purchase of an item will be based on his understanding of the risks in the acquisition cycle and will be reflected in the solicitation he develops.

The structure of a procurement action is in large part affected by its place in the acquisition cycle of a program and the overall acquisition strategy. In turn, an offeror's proposal is driven by the solicitation to which it is

responding. Elements of question six and question eight address the subsidiary research question: What impacts will emphasis on parametric cost estimates have on source selection criteria and on the evaluation of proposals by the DoD? The remaining elements of question six and question nine induce the survey respondent to consider the manner in which a solicitation is conducted.

A central tenet in the Federal Government acquisition process is the fairness of the process. These questions collect data relating to the subsidiary research question: How will source selection criteria and evaluation factors be constructed to fairly evaluate a proposal that uses a parametric cost estimate with one that does not? The final area addressed in the survey is the negotiation process. Question ten collects opinions to answer the question: What effects will using parametric cost estimating have on negotiations? An additional page was attached for comments regarding the questions or any other concerns expressed by the respondents. These additional data have been incorporated into the analysis where applicable.

In each of the questions in the survey, the respondents are asked to record their opinions about the use of parametric cost estimating methods using a numerical scale. Five point numerical scales were selected to provide a consistent, simple

method of coding the responses for data reduction and analysis. Two different scales were used in the survey. Questions one through four used a scale describing the utility of parametric cost estimating methods and questions five through ten used a scale describing agreement with the statements that make up the elements of those questions. Demographic data were also collected in an attempt to describe the population of respondents. The data were examined for relationships between subgroups represented in the survey respondent population and responses for particular questions. Through these methods the data were reviewed, analyzed, and related to the research questions.

An interview questionnaire, Appendix D, was developed in the same manner as the survey instrument. The basic and subsidiary research questions were addressed in the interview questionnaire. The interview questionnaire was presented to seven individuals in personal interviews at the Naval Postgraduate School over the course of the research. Additionally, an initial form of the interview questionnaire was given to six people via telephone and E-mail at the start of the research effort. The information provided has been inserted in the discussion and background areas preceding this chapter as well as in the analysis of the survey data where applicable.

The survey was distributed as widely as possible to attempt to include as many elements of the DoD acquisition community as possible. The bulk of the surveys were distributed by mail using Federal Government agency mailing lists and organizational information. Electronic mail and facsimile transmissions were also used to distribute approximately 25% of the surveys. Potential survey participants were also identified through INTERNET searches and referrals during interviews. Through the survey's wide distribution across the DoD acquisition community, an understanding of the potential for the uses of parametric cost estimating methods was generated. Appendix E is a collection of the data derived from the survey effort.

An important group solicited for input were the members of the Federal Government's Parametric Estimating Initiative Steering Committee. This group was identified following the preface in Reference 36 and represents a cross section of the DoD acquisition community. The Steering Committee came together to identify methods of promoting the uses of parametric cost estimating techniques throughout the DoD community. For purposes of this survey, they responded to a pilot survey with recommendations and suggestions for improvement to the survey structure, direction, and the wording of questions. Their answers to the questions were

also most valuable in that they formed a basis for comparison against which the other demographic groups could be compared. Resident in this group is the most current information about the uses of parametric cost estimating across the entire spectrum of actions inherent in the DoD acquisition process. The Steering Committee is referred to as the control group throughout the analysis portion of this chapter.

C. DEMOGRAPHIC DATA

The survey distribution was tracked through the employer question of the survey. The industry and Federal Government employer categories were all-encompassing, mutually exclusive groupings that were easily tracked. Using this breakdown as a basis, 1260 surveys were distributed over the period 21 August 1996 to 15 October 1996. Throughout the research effort, it was found that many addresses were incorrect. It was assumed that the incorrect addresses resulted from base closures and realignments or agency reorganization efforts. Where possible, correct addresses were obtained and the survey redistributed. Figure 6 represents the survey distribution throughout the data collection effort.

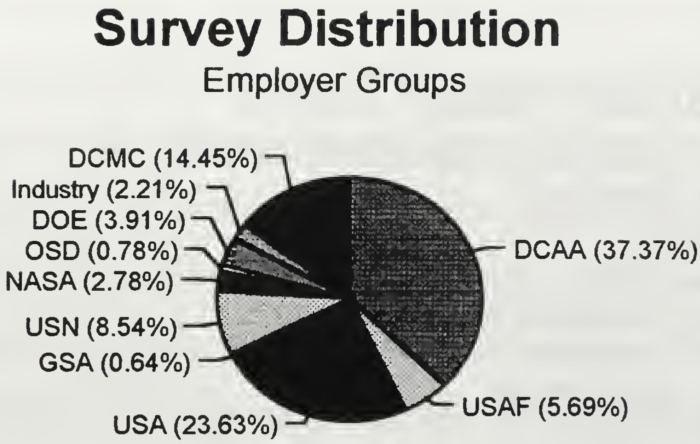
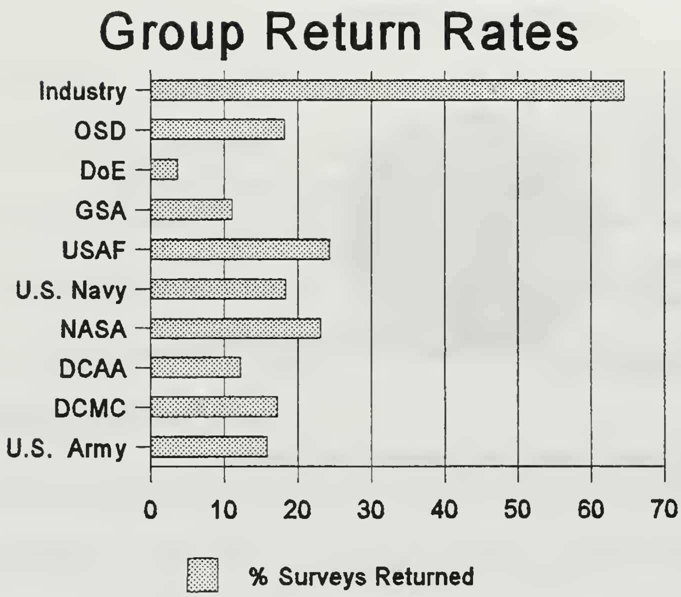


Figure 6: Research Survey Distribution

Source: Developed by researcher.

The majority of the surveys were sent to Federal Government contract support activities, DCMC and DCAA (52%). It was felt that each organization interacting with a major portion of the DoD acquisition community across the entire spectrum of procurement actions would represent the DoD community experience with the uses of parametric cost estimating methods.

A low survey return rate was observed from the data collected from 210 surveys returned. Only 16.5% of the surveys distributed were returned with data to be input for analysis. No opinion or no response to one or more questions was recorded on 47% of the surveys returned. Figure 7 shows the distribution of the returned surveys.



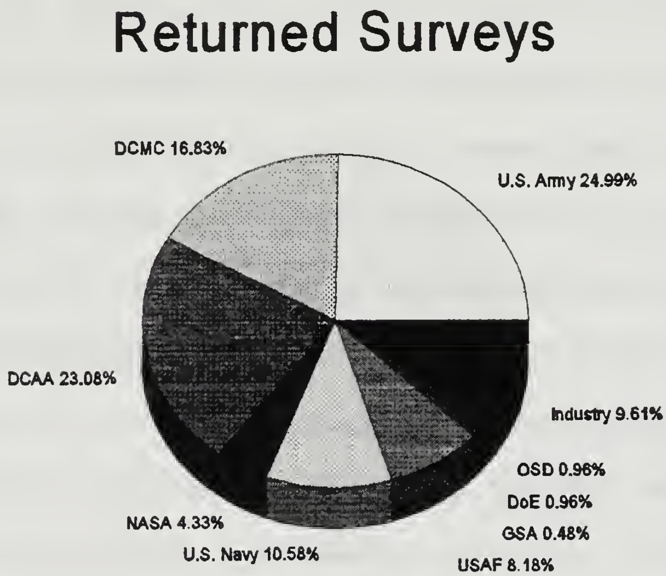


Figure 7: Survey Return Rates

Source: Developed By Researcher

The percentages in the Returned Surveys chart of Figure 7 display the percent of the surveys returned from an employer group. The Group Return Rate chart of Figure 7 shows the percentage of the surveys sent to each group that were returned by members of those targeted employer groups. The percentages of the surveys returned by groups ranged between 68% from industry participants to a low of 3.64% by Department of Energy (DoE) personnel, both small groups within the survey population. Despite the relatively small number of the industry participants targeted (2%), their high return rate made them the fifth largest group contributing to the database. The industry group may have had a disproportionate affect on the response averages because of this high return rate. The remaining groups had fairly similar return rates within a much smaller range of 12% to 25% and formed the majority of the data reviewed.

As the survey was designed to ensure anonymity of the respondent, no effort was made to track response rates by organization within an agency, individually, or by any other demographic breakdown other than that shown above. The researcher was contacted on an individual basis, however, by approximately three percent of the survey population who indicated that they would not be participating. All of these respondents indicated that they were unfamiliar with the topic

and did not feel qualified to join in the survey. While parametric cost estimating methods have been in use within DoD for many years, their use has typically been isolated to upper and middle management areas dealing with major programs. Their use has not been as widespread in the other areas of DoD procurement that make up the bulk of the procurement transactions. [Ref 45:pp.7-11] It is likely that a lack of experience with parametric cost estimating methods is a major factor in the survey's low return rate.

The timing of the survey may also have had a negative impact on the return rate observed. The survey was distributed at the end of the Federal Government's fiscal year, typically one of the most active times of the year in the DoD acquisition community. Although the length of the survey was minimized to encourage participation, the survey had 55 individual data elements to be considered. Many of the recipients may not have had time to complete the survey within the requested time frame and thus chose not to participate.

Demographic data were requested in four areas beyond the employer classification previously discussed. Participants were asked to identify themselves by their job classification, the length of time that they had been working in this area, how they categorized their work, and their level of education in mathematics. Each question was examined with these

categories in mind to identify trends, correlations, or points of interest in the data collected. In terms of job classification, three categories comprised the majority of the survey respondents: those identifying themselves as Cost or Price Analysts (26%), Contracting Officers (23%), and Auditors (22%). Small numbers of participants identified themselves in the remaining job classification groups.

Two employer groups were very homogeneous in composition: the DCMC and DCAA participants. The DCMC group identified themselves almost entirely within the job classification of contracting officer. The DCMC personnel made up 70% of the responding individuals of those identifying themselves as contracting officers. Unlike the DCMC participants, the DCAA group makes up almost all of the auditor job classification respondents. The DCAA and Auditor groups are nearly synonymous, with 96% of Auditors also classifying themselves as working for DCAA. All of the other groups were made up of combinations of the job classifications.

The majority, 49%, of the participants identified themselves within the acquisition community and only 19% in the cost estimating community. A large portion of the respondents did not chose to respond to this question, perhaps overlooking it. There was no observed correlation between either community and any other demographic category similar to

that observed in the auditor and contracting officer job classifications. The majority of the respondents were very experienced in their positions, having more than 10 years of experience in either the acquisition or cost estimating professions. Very few people, 11% of the 210 participants, had less than 10 years experience. Also of note, only 39% of the respondents chose to provide their GS/SES level or military rank. The resulting analyses from these groups are limited because of their small size.

The self-described work classifications are unlike the other demographic breakdowns in that these groups are not mutually exclusive. In question four, respondents were asked to select any of the work functions listed that they performed. They were not to limit their response to any single work function that made up the majority of their work effort. Reviewing or auditing estimates was chosen to describe the work most often performed by the respondents; 103 selected this work description. This group's answers roughly correspond to those in the job classifications of cost and price analyst and auditor. Negotiation preparation and proposal analysis was also selected by a large number of participants, 101 of 210, to describe their work efforts. Here, there is a correlation between this group of responses

and those of the contracting officer, contract negotiator, and auditor job classifications.

Within the database, the majority, 88%, of the respondents answered that they had some degree of college mathematics education. A significant number of the participants had either college level algebra or business calculus, 30% and 33% of the respondents respectively. Of those identifying themselves as having taken an engineering calculus series, only 30% also identified themselves as engineers. The remaining individuals identified were spread across the rest of the job classifications as were the people who answered that they had either advanced degrees or majored or minored in mathematics while a college undergraduate.

After reviewing the basic statistics for the entire database, the database was subdivided and analyzed. The information presented above and the demographic description in Appendix E were used to break the database into separate components to be compared against each other and the entire database statistics. In the following Chapter the comparisons made and analyses performed on the data will be described.

V. APPLICATIONS IN PROGRAM MANAGEMENT FUNCTIONS

A. PURPOSE

This chapter and the following two chapters will discuss the data analysis methods used and results observed in the study. Chapter V analyzes results from question one data related to parametric cost estimating applications in the broad scope of program management functions. Data pertinent to survey question one will be presented, related to the research question, and analyzed. Questions one through four used a five point scale that ranged from "vital to the procurement process," a one on the scale, to "a hindrance to the procurement process," a five on the scale. Each question was further broken into smaller areas of specific interest.

The data from each question were analyzed and the following statistics derived:

1. The number of responses in each of the five categories.
2. An average value of the responses.
3. The standard deviation for the responses.
4. The variation of the responses.
5. The median value of the responses.
6. The skewness of the responses.

These data are presented in Appendix E for the entire group of responses as well as for each demographic group.

Analysis of all the questions and their components was conducted in a similar manner. Descriptive statistics for the entire group are presented, followed by group breakdown information, and the data presentation closes with analysis of variance and regression information. These data are presented in tables following an introductory paragraph. Group data for each question was chosen to be displayed for one of three reasons:

1. Some degree of consensus was observed in the group data analysis

2. The group appeared as a point of interest in the analysis of variance, or

3. The group data are illustrative of a point of interest found during the regression analysis performed.

In both the regression analyses and analyses of variance, a 95% confidence interval was used. For simplicity, group descriptive statistics for the first subgroup in the first question, describing the utility of parametric cost estimating in the area of benchmarking process costs, will be presented in tabular and text format with the data for the remaining questions shown in tabular format only. An analysis of the displayed data will follow those data for each question.

B. BROAD SCOPE UTILITY

The first question asked the respondent to provide an opinion regarding the utility of parametric cost estimating methods in several functional areas. This question was divided into 12 segments, five dealing with overarching functions common to the acquisition cycle in general and seven treating procurement of specific items or services.

1. Benchmarking Process Costs

Benchmarking process cost was the initial subgroup within question 1. Parametric cost estimating methods may have applications in situations where new processes are being developed. The methods may be most useful where these processes are sufficiently similar to past or existing processes and the new processes are expected to have similar cost characteristics or patterns. As a group, the respondents' opinions indicated that they thought parametric cost estimating methods were somewhat useful in this functional area. The largest single group, 56 respondents, selected somewhat useful, a three on the scale, as describing the methods' degree of utility here. Only one respondent thought that the methods could hinder cost estimating if used here and 21 people thought they were of no use.

The corporate policy group selected either vital or very useful to describe the utility of parametric cost estimating

methods in this situation. This agreement is statistically demonstrated in the small standard deviation of .548 for the group and a mean value of 1.4 for all of the responses. These statistics must be tempered, however, with the group size. With only five individuals, it is a very small part of the database of 210. Other small groups had similar occurrences in the data analysis. The program staff group, five persons, three industry cost analysts and the U.S. Army cost analyst group, a group of nine, were unanimous in their belief that parametric cost estimating methods were somewhat useful for benchmarking process costs. U.S. Air Force cost analysts, another small group of five, agreed with the cost analyst from the General Services Administration (GSA) that the methods were very useful for this purpose. These data described are displayed in Table 3. Analyses of variance and regression analyses pertinent to question one and discussions of these results follow. No other trends or indications were observed from the group statistics analyzed.

Other analyses performed with the data from this question were analysis of variance and regression analysis. In reviewing the results shown in Table 4, a relationship was noted between job classification and the responses for benchmarking process costs. A p value of .04 indicates that a relationship exists between the responses in the job

classification group and their answers for benchmarking process costs.

Table 3
Benchmarking Process Costs Group Data

Group Description	Min	Max	μ	Median	σ	Q1	Q3
Corporate Policy	1.00	2.00	1.40	1.00	.55	1.00	2.00
Program Staff	3.00	3.00	3.00	3.00	.00	3.00	3.00
Industry Cost Analysts	3.00	3.00	3.00	3.00	.00	3.00	3.00
USA Cost Analysts	3.00	3.00	3.00	3.00	.00	3.00	3.00
USAF Cost Analysts	2.00	2.00	2.00	2.00	.00	2.00	2.00
GSA Cost Analysts	3.00	3.00	3.00	3.00	.00	3.00	3.00

Source: Developed by researcher.

A point of interest in this analysis is in the difference of opinion between the program managers and other job classification groups. The six program managers who chose to respond to this question believed that the methods were vital or very useful in benchmarking process costs. The other groups felt that the methods were either very useful or only somewhat useful for this application. Analysis of variance between the question responses and the DoD employer categories also showed that a relationship exists. The majority of the participants (87), represented by the U.S. Army, DCMC, and

DCAA, responded that the methods were somewhat useful where the remaining respondents (31) answered that the methods were very useful to the process.

Table 4
Analysis of Variance For Benchmarking Process Costs

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	8	11.91	1.49	2.09	.04
Within Groups	120	85.30	.71		
DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	10.55	1.76	2.95	.01
Within Groups	111	66.07	.60		

Source: Developed by researcher.

Regression analysis for this question displayed relationships between the respondent's level of mathematics education and their answers. The mathematical nature of parametric cost estimating methods led to the belief that as one's mathematics education increases so does familiarity with the concepts employed in them. This in turn should lead to greater confidence in the proper application of the methods by these same individuals. There also was a relationship between General Service/Senior Executive Service (GS/SES) level or military rank for Federal Government employees and their responses. In both of these regression analyses, the groups observed agreed with the main body of respondents in the

degree of utility for parametric cost estimating methods in benchmarking process costs. These two groups displayed a specific trend beyond that initial observation, however.

The regression analysis for the mathematics education relationship yielded a p value of .02 for the six subgroups reviewed. This value indicates a relationship does exist between the data points, which can be described as weak in the following equation:

$$\underset{(.14)}{Y = -.337(X)} + \underset{(.40)}{38.3} \qquad R^2 = .033$$

(The values in parentheses represent standard errors of the above coefficients.)

In this analysis, as an individual's mathematics education increases the numerical value of their responses decreases. A lower value indicates greater utility because of the inverse construction of the response scale used where a one indicated the greatest utility and a five the least utility. The small value of the coefficient of determination, R^2 , shows that little of the variation in the dependent variable, responses, is due to the independent variable, mathematics education.

Similar results were observed in the analysis comparing the responses with the GS/SES level or military rank. The regression equation for this analysis

$$\underset{(.21)}{Y = -.445(X)} + \underset{(2.98)}{8.68} \qquad R^2 = .134$$

shows that as seniority increases, so does the respondent's opinion of the utility of parametric cost estimating for benchmarking process costs. This relationship can also be described as weak.

Although there were a large number of people who did not choose to offer an opinion, most of those that did saw some promise in using parametric cost estimating methods for benchmarking process costs. Groups indicating a high degree of utility for them also are typically in an oversight, upper management position or those working to directly support others in those positions. These individuals are more likely to view a problem in a systems or process approach and may be more experienced with using parametric cost estimating methods in the area of benchmarking process costs than the group as a whole.

This area of cost analysis is one that may take on more prominence in the future with parametric cost estimating methods playing a significant role. As DoD reliance on military specifications and standards is reduced, the cost estimating techniques built on those standards will become less reliable. Greater dependence on performance specifications may require the DoD acquisition community to analyze commercial processes that have had little or no prior application in DoD acquisition processes. The DoD Single

Process Initiative (SPI) may provide opportunities to use parametric cost estimating methods to benchmark process costs. With supervisory personnel experienced in and amenable to their use, parametric cost estimating methods should see additional future applications in benchmarking process costs.

2. Validating Bottoms Up Estimates

Traditionally, using parametric cost estimating methods in this area involves comparisons between the parametric cost estimate and the project's bottoms up estimate. With a long history of use in these applications, the aggregate data showed a strong trend toward acceptance of the idea that parametric cost estimating methods were somewhat useful to validate bottoms up estimates. Only 20 responses were coded for no use or a hindrance to validating bottoms up estimates while there were 140 responses indicating opinions that the methods were at least somewhat useful in these situations. Group breakdown data of interest are presented in Table 5 while Table 6 contains analysis of variance data.

Examination of the analysis of variance data showed those identifying themselves as engineers and program managers believed that parametric cost estimating methods were more useful than did the other job classification groups. There is a significant difference between the upper level management's opinion of their utility and that of their supporting

organizations. Support groups are represented by the program staffer and engineer group data in Table 5.

Table 5
Validating Bottoms Up Estimates Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Staff	3.00	3.00	3.00	3.00	.00	3.00	3.00
Corporate Policy	1.00	2.00	1.40	1.00	.55	1.00	2.00
Engineers	1.00	4.00	2.88	3.00	1.1	2.00	4.00
Program Managers	1.00	3.00	1.50	1.00	.84	1.00	2.25

Source: Developed by researcher.

Table 6
Analysis of Variance For Validating Bottoms Up Estimates

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	15.37	1.71	2.45	.01
Within Groups	144	100.53	.70		

Source: Developed by researcher.

The program managers and those who set corporate policy felt that the methods were vital or very useful in this area while the engineers and program staffers thought that the methods were only somewhat useful in this functional area. This divergence of opinion may be a result of program staffers and engineers who had closer involvement with the techniques and methods than the program managers and those who set

corporate policy. The weak negative relationship exhibited in the regression analysis

$$\underset{(.05)}{Y = -.119(X)} + \underset{(1.90)}{7.11} \qquad R^2 = .033$$

supports the contention that the upper level supervisors have a higher opinion of the method's utility than do the support organizations. The small R^2 value indicates a weak relationship, however.

Parametric cost estimating methods will continue to be used to validate bottoms up estimates. This function is one of the traditional uses for parametric cost estimating for which there is still a need. A large part of the DoD acquisition community is familiar with their application in validating estimates derived from other sources. Certain situations lend themselves to the development of bottoms up estimates, and the subsequent need to have them validated against some standard will always remain. These factors should continue to encourage the use of parametric cost estimating methods in validating bottoms up estimates.

3. Program Estimates

Developing program estimates is also an area of application for parametric cost estimating. Consideration of the total costs for a program or system has always been a concern and is becoming more important in acquisition planning. In the aggregate analysis, the majority of the

participants felt that the methods were useful to some degree in developing program costs. Only seven respondents answered that there was no use for parametric cost estimating in program estimating and no one responded that they were a hindrance. The average response value for the entire database was 2.25 with a standard deviation of .82. Demographic group statistics of interest are shown in Table 7, and Table 8 contains analysis of variance information.

In the examination of the analysis of variance data for job classifications, program managers, engineers, and contract negotiators had somewhat lower group response averages than did the remaining job classification groups represented in Table 7. Analysis of variance of the DoD component responses also showed some interesting trends. The DCAA group's response average was higher than that of every other group while the industry group had the lowest response averages. The DCAA group opinions are noteworthy as they represent a fairly homogenous response from a large subset, 33 responses to this question, of all of the responses. DCAA has a significant part in the DoD acquisition process. They have published guidance on the auditing procedures for parametric cost estimating methods.

The NASA responses may be an outgrowth of the nature of the work NASA performs. NASA has a great deal of experience

with using parametric cost estimates in numerous developmental projects and may be more experienced in their use than the DoD organizations. The NASA respondents also have one of the highest average levels of mathematics education of the groups surveyed. The DCAA responses may reflect distance from the program estimating functions and a different definition of what constitutes program estimating than that used in the other groups. Also of note is that the DCAA group had one of the lowest mathematics education levels of the groups surveyed. These factors may combine to produce the divergence of opinion in the utility of parametric cost estimating methods between these two groups.

Table 7
Program Estimates Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Managers	1.00	3.00	1.29	1.00	.76	1.00	1.00
Industry	1.00	3.00	1.47	1.00	.72	1.00	2.00
Contract Negotiators	1.00	2.00	1.50	1.50	.58	1.00	2.00
NASA	1.00	4.00	1.57	1.00	1.13	1.00	2.00
Engineers	1.00	3.00	1.78	2.00	.83	1.00	2.50
DCAA	1.00	4.00	2.76	3.00	.71	2.00	3.00
Program Staff	3.00	3.00	3.00	3.00	.00	3.00	3.00

Source: Developed by researcher.

Table 8
Analysis of Variance For Program Estimates

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	8	19.17	2.40	4.43	.00
Within Groups	141	76.33	.54		
DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	14.11	2.35	4.41	.00
Within Groups	132	70.32	.53		

Source: Developed by researcher.

The data and statistics for this question appear to have contradictory indications. The program manager and program staff groups had different opinions of the utility of parametric cost estimating methods; the program managers felt they were vital or very useful while the program staff felt that they were only somewhat useful. The experience and mathematics education response values for these two groups may explain this divergence. The program managers have a significantly higher mathematics education level on average than do the program staff but a lower experience average.

The relationships between the two regression analyses seems to be contradictory. Two of the groups with the most experience have widely divergent opinions about the utility of the methods in program estimating. One would expect that as experience increases so would someone's familiarity with

parametric cost estimating methods, their uses and limitations. The experience regression equation

$$\underset{(.08)}{Y = .261(X)} - \underset{(2.39)}{5.13} \qquad R^2 = .053$$

indicates a weak positive relationship exists. More experience leads to a belief that the methods are less useful in program estimating. The mathematics education regression analysis

$$Y = \underset{(.05)}{-.118(X)} - \underset{(1.75)}{7.03} \qquad R^2 = .033$$

shows a weak negative relationship. The DCAA responses exemplify these two equations. Their view of the utility of the methods in this functional area is low when compared to the other groups, and they are one of the most experienced groups, but they also have one of lower mathematics education averages of the groups.

The DCAA group had lower opinions of the utility of parametric cost estimating methods in this application than did the other groups. This may represent a more detailed working knowledge of the uses of the methods and their limitations than the other groups had. It also may be a result of a different view of what is included in the definition of a program estimate. These groups may have used a more restrictive definition of a program estimate than did the remaining groups. In restricting the definition to

specific functional estimates produced at various times during a program cycle, they may have been more skeptical about using parametric cost estimating methods than the program managers who may have taken a more expansive view of the definition. The majority of the groups in Table 7 show a trend towards acceptance of the use of these methods for producing program estimates.

4. Budgeting

Budgeting is another area in which parametric cost estimates have a long history of use. They have been produced for rough order of magnitude budgeting as well as for more specific estimates in the budgeting process. The overall database information had all but nine participants indicating their belief that parametric cost estimating had some use in budgeting decisions. The majority of the respondents chose the descriptor very useful as their response to the question. The average response value was 2.2 with a standard deviation of .85 for the responses. Table 9 displays the group breakdown data applicable to this question with Table 10 presenting analysis of variance data.

The subgroups identified as cost or price analysts and contracting officers were of note in the analysis of variance. Both of these groups represent large sections of the database, 45 and 36 responses to this question respectively, with

relatively small standard deviations for both groups. The U.S. Army and DCAA subgroups were also identified in the analysis of variance as being of note. These two groups also represent major parts of the database, and when compared with the other DoD component groups, they show relatively tight data groupings with response average values larger than those of the other DoD component groups. These four groups all responded that the use of parametric cost estimating methods were of some use in the budgeting process.

Three other groups, program managers, contract negotiators, and those that set corporate policy, responded that the methods are vital or very useful to the budgeting process. The responses from the program managers and industry are of special interest. Of the groups who would be expected to have considerable experience in budgeting, they have the highest opinion of the utility of the methods in budgeting. The data from the DCAA and program manager groups are supported by the mathematics education regression analysis. The equation

$$\underset{(.04)}{Y = -.137(X)} + \underset{(1.66)}{7.33} \qquad R^2 = .051$$

indicates that there is a weak negative relationship demonstrated in the DCAA high average response to this question and relatively low mathematics education average when

compared with other groups. The program managers have opposite characteristics with one of the highest mathematics education levels and low average response to this question.

Table 9
Budgeting Group Data

	Min	Max	μ	Median	σ	Q1	Q3
U.S. Army	1.00	4.00	2.51	3.00	.73	2.00	3.00
DCAA	1.00	4.00	2.63	3.00	.77	2.00	3.00
Cost or Price Analysts	1.00	4.00	2.23	2.00	.70	2.00	3.00
Contracting Officers	1.00	4.00	2.28	2.00	.78	2.00	3.00
Program Managers	1.00	3.00	1.57	1.00	.79	1.00	2.00
Contract Negotiators	1.00	2.00	1.25	1.00	.50	1.00	1.75
Corporate Policy	1.00	2.00	1.60	2.00	.55	1.00	2.00

Source: Developed by researcher.

Reviewing the results of the analysis leads one to believe that parametric cost estimating applications in budgeting should continue their long history of use. As the data show, there are a large number of groups in the DoD acquisition community who feel strongly that parametric cost estimating methods are useful techniques for budgeting. The increased prominence that they are given through the Parametric Cost Estimating Initiative will widen the knowledge

about their uses in the community. The increasing accuracy and speed at which these type of estimates can be generated make them a formidable tool for contingency analyses in an environment of funding uncertainty. From their already wide acceptance base, this should lead to more applications in budgeting in the future.

Table 10
Analysis of Variance For Budgeting Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	20.97	2.33	3.97	.00
Within Groups	145	85.22	.59		
DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	10.48	1.75	2.92	.01
Within Groups	131	78.34	.60		

Source: Developed by researcher.

5. Independent Cost Estimate (ICE) Generation

Generating independent cost estimates is an important part of any acquisition planning process. They may be used in any number of program functions to include program estimates or budgeting. Parametric cost estimating is one of the tools that can be applied to generate these estimates. Responses to this segment were centered between very useful and some use. No responses reflected the opinion that the methods would be a hindrance to generating ICE generation. There were a large number of no responses to this question, however. The average

response value was 2.34 and the median value was 2, or very useful. In the analysis of variance the engineers believed that the use of parametric cost estimating had the most application to ICE generation of the groups. They indicated that the methods were very useful while the remaining job classification groups felt that the methods were only somewhat useful for ICE generation. Tables 11 and 12 contain the group specific data and analysis of variance for this segment of question one.

Table 11
ICE Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	3.00	2.00	2.00	.94	1.00	3.00
USAF	1.00	3.00	2.07	2.00	.73	1.75	3.00
Engineers	1.00	3.00	1.46	1.00	.69	1.00	2.00

Source: Developed by researcher.

Table 12
Analysis of Variance For ICE Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	16.83	1.87	2.29	.02
Within Groups	104	84.79	.82		

Source: Developed by researcher.

The responses of the engineer job classification group indicated the highest level of regard for the utility of parametric cost estimating for producing ICEs. This group is

representative of those in the DoD acquisition community tasked with ICE generation and who are familiar with the process. They also have one of the highest average mathematics education levels of any group in the database. These factors indicate a viable application for using parametric cost estimating methods in ICE generation exists, and there is a base of expertise in their use in this area.

The high regard that the control and USAF groups had for the use of parametric cost estimating methods for ICE generation is also indicative of their application potential. The control group has been studying the use of the methods and they have responded that the techniques are very useful in this area. Regression analysis revealed the following relationship between answers for this question and the respondents' mathematics education levels.

$$\underset{(.06)}{Y = -.169(X)} + \underset{(2.14)}{8.74} \qquad R^2 = .062$$

The weak negative relationship between the answers and the mathematics education responses supports the observation that these groups would strongly support the use of parametric cost estimating methods for ICE generation.

The application of parametric cost estimating methods to producing ICEs will continue and become more prevalent. DoD Regulation 5000.2-R states, "As defense resources decline, the margin available for adjustments narrows, making realistic

cost projections all the more critical." [Ref 44] Parametric cost estimating has and will continue to fulfill a major role in producing ICEs to meet this need. The groups cited in Table 11 are important members of the DoD acquisition community who favorably view the application of parametric cost estimating methods to ICE generation. With the emphasis from the control group on the potential uses of the methods, the engineers representing the users of the methods in this area, and the auditor group noting that the methods have some application in the production of ICEs, they should certainly find wider use in future procurement actions and planning.

6. Software Contracts

There are a host of databases and computer programs that were developed for the purpose of estimating costs and schedules for software development. Examples such as COCOMO and PRICE-S were cited earlier in the text. The cumulative data showed that the largest part of the respondents indicated that parametric cost estimating methods had some use in software contracts. Few of the participants (27) thought that they had no use. The average response value to this question was 2.54 and a median value of 3 was observed from the aggregate data.

In reviewing the group data, the USAF was observed to have a somewhat higher regard for the application of

parametric cost estimating methods to software contracting than the main body of the participants. USAF group data, an average response value of 2.07 with a .616 standard deviation and median value of 2, indicate a view that the methods are very useful in this area. The USAF has been greatly involved in the use of parametric cost estimates for estimating software development costs. The USAF Cost Analysis Agency has produced a revised COCOMO model for this express purpose. This versatile model can be used to produce a variety of outputs throughout the life cycle of a software product.

Parametric cost estimating has a strong base of application as a tool in the area of software cost estimating. Estimating the costs of and schedule for software development has been a historically difficult area. The increasing importance of software in DoD systems and equipment could make this a growth area for the future. Parametric cost estimating methods should become more useful for software cost estimate generation as databases become more interconnected.

7. Repair Parts Contracts

Aggregate data analysis presented a view that parametric cost estimating methods had some utility in producing cost estimates for repair parts contracts. The average response value was 2.85, a median value of 3 and a normal distribution of the data around that value was observed. Table 13 shows

the group data for contracting officers and those that set Government policy. The groups shown are noted for their concurrence within their groups demonstrated by the small standard deviations identified for each group. Both groups can also potentially play a major part in the use of parametric cost estimating in repair parts contracting. Those that set Government policy (through regulation or directive) and contracting officers (through applying the methods in specific procurement actions) have the potential to directly encourage or discourage the use of parametric cost estimating methods in this area. That these groups both indicate that they see limited use for the methods in repair parts contracting would seem to limit their uses here.

Repair parts contracting is not normally an area in which the methods of parametric cost estimating are applied. Generally the costs or prices are fairly well established through historical prices. The need for estimating repair parts cost or prices typically occurs later in the life cycle than the stages in which parametric cost estimating methods are used. Parametric cost estimating methods could be used in an overall estimate of repair parts costs for a system or piece of equipment much more readily than for an individual procurement action. The data reflect a preference for other

cost or price estimating methods to estimate repair parts costs over the use of parametric cost estimating methods.

Table 13
Repair Parts Contracting Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Contracting Officers	2.00	4.00	2.85	3.00	.57	2.50	3.00
Government Policy	2.00	4.00	3.05	3.00	.67	3.00	3.50

Source: Developed by researcher.

8. R&D Contracts

R&D contracting is an area in which parametric cost estimating can be applied in a number of areas. The types of items and services procured in R&D contracting are developmental in nature, and estimating costs or prices can be difficult. The database analysis for the entire response group yielded an almost equal distribution between the very useful, somewhat useful and no use descriptors, 41, 49, and 40 responses respectively. An average response value of 2.83 indicates a somewhat useful viewpoint throughout the DoD acquisition community regarding the utility of parametric cost estimating methods to R&D contracting. The NASA participants had the highest regard for their applicability in the analysis of variance. Job classification and DoD component data for

the analysis of variance is displayed in Table 15. DCAA responses indicated that in their view the methods were of some or no use to R&D contracting.

Table 14
R&D Contracting Group Data

	Min	Max	μ	Median	σ	Q1	Q3
DCAA	2.00	5.00	3.53	4.00	.80	3.00	4.00
USAF	1.00	4.00	2.21	2.00	.89	2.00	2.25
NASA	1.00	3.00	1.67	1.50	.82	1.00	2.25
Technical Support	3.00	4.00	4.00	4.00	1.00	3.00	4.00

Source: Developed by researcher.

The NASA and USAF data indicate that there are some in the DoD acquisition community that feel that parametric cost estimating methods can be used in R&D contracting. It is also of interest that the technical support group participants were the group that had the highest average response rate of all the groups. The response rate shown in Table 14 indicates that this small group believes that the methods have no use in R&D contracting.

The mathematics education regression analysis supports the observations regarding the groups in Table 14. The regression equation

$$\underset{(.05)}{Y = -.200(X)} + \underset{(2.01)}{10.3} \qquad R^2 = .078$$

indicates that there is a weak negative relationship between mathematics education and the responses for this question. The NASA participants had a higher average mathematics education level than did the other groups and they also felt that the methods had more use in R&D contracting than did the other respondents.

Table 15
Analysis of Variance For R&D Contracting Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	31.44	3.49	3.62	.00
Within Groups	138	133.29	.97		
DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	28.32	4.72	5.42	.00
Within Groups	127	110.61	.87		

Source: Developed by researcher.

The application of parametric cost estimating methods should continue to be used in this area where the groups mentioned have found them useful. Increasing budgetary pressures have restricted spending on R&D throughout DoD and it is likely that R&D funding will be restricted in the future. A lack of useful databases in the R&D field may be contributing to the view of almost one third of the respondents that parametric cost estimating methods are of no use. While parametric cost estimating cannot be used for

every instance, the methods do have the potential to produce sound estimates for R&D applications.

9. Service Contracts

Acquisition of services forms a significant part of the Federal Government's procurement activity. Parametric cost estimating methods have not been widely applied to this area of acquisition in the past. The majority of the responses to this segment were split between some use and no use with 57 responses for each choice. The average response value from the database was 3.09 and the median response value was 3. These indicate that the participants felt there was only some use for the methods in service contracting. The results of the analysis are shown below in Table 16.

Service contracting usually does not have the characteristics that make it amenable to using parametric cost estimating techniques. The procurements in service contracting are not often quantifiable in terms of parameters that are easily measured and then related to outputs in a database. There are few existing databases and software products that are used in this area. The control group average response rate supports this view in their opinion that parametric cost estimating methods do not have any use in the area of service contracting. The rather large standard deviation indicates a lack of consensus within this group,

however, but at no point does anyone in the group advocate that the methods have any more than some use in service contracting.

Table 16
Service Contracting Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Set Corporate Policy	3.00	4.00	3.25	3.00	.50	3.00	3.75
Control Group	3.00	5.00	4.17	4.00	.98	3.00	5.00

Source: Developed by researcher.

The group of respondents that set corporate policy differs in their opinion but only slightly. Their answers lead one to believe that they feel that the methods have some use in this area of contracting. Unlike the control group, those that set corporate policy have a closer consensus regarding the methods' application in service contracting evidenced by the small standard deviation in a group twice the size of the control group.

Defining services to be acquired by performance standards may allow greater use of parametric cost estimating methods in service contracting. Performance specifications are the preferred method of describing supplies or services required by the Federal Government. With this emphasis and increased awareness of parametric cost estimating methods, the techniques may see more use in this area of Federal Government procurement.

10. Hardware Contracts

Although hardware can be defined in terms of components, assemblies or subassemblies of an electrical, mechanical, or electronic piece of equipment, the definition used here is more limited. Hardware contracting for this study refers to contracting for computer hardware, equipment, or peripherals. The rapid pace of development in the computing field leads to the use of parametric cost estimating in this area. The data and analysis apply equally as well to a broad definition of hardware as they do to the narrower definition used in this study.

Database analysis revealed that the majority of the respondents answered that the methods were very useful or of some use in hardware contracting, 54 and 59 responses respectively. Some use was the median response and an average response value was 2.55. Contracting officers were the only group that showed a consensus, a standard deviation of .62 was observed, in their responses to this question. In their position, they are also one of the groups that could best apply the methods to contracting for hardware. Their responses with a mean of 2.65 and median value of 3 indicate a view that the methods are of some use in this area.

While the methods may have application in producing estimates to be used in the area of hardware contracting, the

drive to use Commercial-off-the-Shelf Technology (COTS) and Non-developmental Items (NDI) may restrict their uses by the Federal Government in this area in the future. COTS items and NDI are by definition beyond the stage in which parametric cost estimating methods are typically applied in the product life cycle, as shown in Figure 1. If the item is truly a COTS item or NDI there should be ample pricing data available from the commercial environment and less need to apply the techniques to this area of Federal Government acquisition. This type of acquisition environment may, however, hold some promise for the use of parametric cost estimating methods. The methods may be used to estimate the costs of integrating the various COTS items and NDI that may be purchased to meet an agency's needs rather than for the equipments themselves.

11. Construction Contracts

Parametric cost estimating methods have been successfully applied to many construction projects. There are plentiful data and output parameters in construction that lend themselves to using parametric cost estimating methods. The CPRG uses a construction example to illustrate the development of concepts and CERs in parametric cost estimating. Some use was the choice of 54 of the respondents to the survey. There were a significant number of participants (79) who elected to not respond to this segment of question one. An average

response value for the participants of 2.71 was observed and the median response was the some use descriptor. The group response data are presented below in Table 17.

Table 17
Construction Contracting Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Contracting Officers	2.00	4.00	2.79	3.00	.78	2.00	3.00
Negotiators	1.00	2.00	1.75	2.00	.50	1.25	2.00
Government Policy	2.00	4.00	2.86	3.00	.72	2.00	3.00

Source: Developed by researcher.

The contract negotiator response is of particular interest in Table 17. This group indicated that they believed that there was greater utility for parametric cost estimating methods in construction contracting than did the other participants and groups. The contract negotiators indicated the methods were vital or very useful in the area of construction contracting while others felt that they were only of some use in the process.

The contract negotiators' consensus on this question is also noteworthy when compared with the responses from the contracting officers. With similar training and experiences, one would expect similar responses from both groups. The contracting officers, however, felt that the methods were only

of some use in construction contracting. These individuals and those that set Government policy can be most influential in applying the methods in this area, and both do not see the methods contributing significantly in this area.

Parametric cost estimating methods should continue to be employed in estimating for construction contracting. They have an established basis for use outside the DoD and a large part of the DoD acquisition community involved in construction contracting is aware of how they can be best applied to this area. Base consolidations and relocations could offer additional opportunities for using parametric cost estimating methods in construction projects.

12. Commodity Contracts

Contracting for commodities, such as fuels, clothing, or food items, is a significant and vital part of the DoD acquisition workload. Commodities may defined as commercial items sold in substantial quantities to the general public exemplified by the group and class categories in the GSA catalogs. Aggregate group analysis showed that the majority of the responses to this question were split between some use and no use in this area, 51 and 41 responses respectively. The analysis also showed a median response value of 3 and average response value of 3.23 with a standard deviation of .78. The small standard deviation indicates that a consensus

on this question exists. No group in the analysis deviated from this opinion.

Pricing for commodities is normally accomplished using market pricing mechanisms. As a result, there are few opportunities for the use of parametric cost estimates. The aggregate group data presented support the idea that the methods have limited application in commodity contracting. This situation is unlikely to change significantly because market prices are one of the preferred pricing methods for commodity items.

C. SUMMARY

Question one was broken into 12 segments to take a broad view of some of the major areas in the acquisition process to which parametric cost estimating may be applied. The results of the analysis conducted across these areas showed the opinions of the DoD acquisition community regarding the applicability of the methods. Overall, the methods were seen to be most applicable to the program estimating, budgeting and ICE generation and least applicable to commodity contracting. In all of the other areas the respondents indicated there was some use for the techniques.

VI. SPECIFIC APPLICATIONS

A. PURPOSE

Questions two through four ask the participants to rank the utility of parametric cost estimating methods across a series of specific applications in program management and contract situations. Question two addresses system life cycle concerns as defined in DoD Regulation 5000.2-R. Figure 1 presents a typical pattern of applying the methods throughout the four life cycle phases. Question three presents data on the uses of parametric cost estimating methods in specific contract type situations. Finally, question four addresses applications in pre-award and post-award contract actions.

B. PROGRAM LIFE CYCLES PHASES

1. Concept Exploration

In the first phase of a system's life cycle, concept exploration (CE), a series of short term, independent studies are conducted. These studies attempt to evaluate various concepts that are proposed to meet a requirement. Parametric cost estimating, as shown in Figure 1, is not the primary cost estimating method in this phase. The aggregate responses were essentially evenly spread across the three utility descriptors and no responses. Vital, very useful, some use, and no responses garnered 39, 48, 43, and 39 answers respectively.

The dispersion of responses indicates a lack of agreement on the answer to this question which is also identified in the large standard deviation of 1.09. The average response value of 2.46, a median value of 2 and a positively skewed distribution indicate that the participants felt that the methods were very useful in this life cycle phase.

The job classification analysis of variance data highlighted the control and NASA groups. Their responses indicated that for this phase they felt the methods had the most utility of all of the groups. The auditor job classification group was identified as believing that the methods had the least degree of utility in this life cycle phase. These results may be an outcome of the experience that the control and NASA groups have with this phase of program management and the lesser degree of experience that the auditors may have with it. Tables 18 and 19 contains these data.

The low response averages for the program staff, NASA, and control groups for this question are noteworthy. These groups represent high mathematics education levels and are familiar with the actions required in each of the phases of a system's life cycle. The mathematics regression analysis also supports this. The regression equation and data

$$Y = \underset{(.05)}{-.271}(X) + \underset{(1.99)}{12.6} \qquad R^2 = .132$$

show a weak negative relationship between the responses and the mathematics education level of the participants. These groups indicated that they believed that the methods were very useful in the concept exploration phase. The data from analysis of the auditor and contracting officer responses show that they feel that the methods are only of some use in this phase.

Table 18
Concept Exploration Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Staff	2.00	2.00	2.00	2.00	.00	2.00	2.00
Control Group	1.00	3.00	1.45	1.00	.69	1.00	2.00
NASA	1.00	4.00	1.50	1.00	1.07	1.00	1.75
Auditors	1.00	4.00	3.13	3.00	.91	2.00	4.00

Source: Developed by researcher.

Table 19
Analysis of Variance For Concept Exploration Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	28.99	3.22	2.97	.00
Within Groups	149	161.35	1.08		
DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	26.25	4.37	4.17	.00
Within Groups	134	140.73	1.05		

Source: Developed by researcher.

The CE phase activity is centered on reviewing various solutions to a problem vice analyzing a specific solution. It is not until a general course of action is decided on that system measures of effectiveness or performance can be developed. Without some general definition of how a solution to the problem is to be described, a database cannot be selected for analysis nor are there any parameters to evaluate. Once this has been accomplished, parametric cost estimating methods can be successfully used in this area of program management. In this phase, they may have more application as rough order of magnitude planning tools in budgeting or for conducting cost and performance tradeoff analyses early in a program than for specific cost or schedule estimates.

2. Program Definition & Risk Reduction

Activity in the PD&RR phase centers on the evaluation of the problem solution identified at the Milestone I decision point. Defined in DoD Regulation 5000.2-R, these activities may include prototyping, testing, and early operational assessment of critical systems, subsystems, and components. [Ref 43:p.4] Actions, such as these, are taken to identify and reduce risk in the early stages of a program. Responses to this segment of question two were concentrated on very useful, 60 responses, and some use, 58 responses. An average

response value of 2.43 and median answer of very useful was observed.

Analysis of variance results highlighted the corporate policy, NASA, program staff, and control groups as particularly interesting. These groups believe that the methods are vital to this phase of a system's life cycle. In fact, the program staff members were unanimous in their opinion that the methods were very useful in the PD&RR phase. Data analysis results are displayed in Tables 20 and 21. The view expressed by the groups that the methods have a great deal of utility in this phase is noteworthy. Most of the groups work in this area of program management or have experience in performing the functions in this phase and represent a cross section of upper level management in the DoD acquisition community.

Table 20
PD&RR Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Staff	2.00	2.00	2.00	2.00	.00	2.00	2.00
Control Group	1.00	2.00	1.55	2.00	.52	1.00	2.00
Corporate Policy	1.00	2.00	1.20	1.00	.45	1.00	1.50
NASA	1.00	4.00	1.57	1.00	1.13	1.00	2.00

Source: Developed by researcher.

Figure 1 presents the view that parametric cost estimating is most useful in this stage of a system's life cycle. This is demonstrated by the response averages and standard deviations of the groups shown in Table 20. The following regression equations support this observation.

Mathematics Education

$$Y = -.201(X) + 9.95 \qquad R^2 = .099$$
$$\quad (.05) \qquad (1.70)$$

GS/SES Level/Rank

$$Y = -.343(X) + 7.09 \qquad R^2 = .094$$
$$\quad (.16) \qquad (2.24)$$

Although these relationships can be described as weak, they do indicate that as one's mathematics education and rank increase the belief in the utility of parametric cost estimating methods to PD&RR becomes stronger.

Table 21
Analysis of Variance For PD&RR Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	15.58	1.73	2.12	.03
Within Groups	153	124.73	.82		
DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	13.37	2.23	2.93	.01
Within Groups	138	140.86	.76		

Source: Developed by researcher.

Applications for parametric cost estimating in the PD&RR

phase are widespread and well developed. They should continue to be used in this phase and become more important as they become more accurate and rapidly generated. There is a concurrence in the opinions regarding their utility across the DoD acquisition community represented by the corporate policy, program staff, and control groups. The applicability and experience in their use by such a range of acquisition professionals should ensure that they are used where they will provide the most benefit.

3. Engineering & Manufacturing Development

In the Engineering & Manufacturing Development phase (E&MD), one of the functions is to define and perfect the manufacturing processes to be used to produce the equipment selected at the Milestone II decision point. These processes provide opportunities for the use of parametric cost estimating methods. During E&MD, Figure 1 shows parametric cost estimating methods being used to validate bottoms up estimates also. This phase is the transition point between the defined solution and production of equipment representing that solution.

Participants responded to this question with 62 responses in the very useful and 76 responses in the some use descriptor categories. There was an average response value of 2.45 and the median response was for some use in the E&MD phase.

Analysis of variance showed that, of the employer groups, the DCAA represented this overall view that the methods had only some use in E&MD. They were joined in this belief by the U.S. Army, a major buying organization in the process.

In the group data, the responses of the cost estimators and those who set corporate policy were interesting. The corporate policy group responses show a greater utility for the methods here than do the cost estimators. The cost estimators believed, as did the DCAA group, that the methods have limited application in the E&MD phase while those who set corporate policy believe that it is vital to the process to use them in the E&MD phase. This divergence of opinion between these groups is noteworthy in that all of these groups have a major role in program management at this phase. Tables 22 and 23 contain the group analysis and analysis of variance data for E&MD responses.

Table 22
E&MD Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Cost Estimators	1.00	3.00	2.96	3.00	.66	2.00	3.00
Corporate Policy	1.00	2.00	1.40	1.00	.55	1.00	2.00
DCAA	1.00	4.00	2.79	3.00	.70	2.00	3.00
U.S. Army	1.00	4.00	2.61	3.00	.70	2.00	3.00

Source: Developed by researcher.

This divergence of opinion may represent the different applications of the methods in the same functional areas by the commercial and Federal Government sectors of the acquisition community. The Federal Government interest in the application of business practices in the operation of Government may benefit if this assumption holds true. As the methods become more widely known and adaptable they should be used with greater frequency in this phase of programs of all types.

Table 23
Analysis of Variance For E&MD Data

DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	8.52	1.42	2.51	.03
Within Groups	139	78.73	.57		

Source: Developed by researcher.

The existing experience with their uses may be expanded by the emphasis on cost-benefit tradeoffs that are now encouraged by DoD upper management levels. Evaluating new processes or processes not previously used in production of DoD systems also provide additional avenues for using the methods more widely during the E&MD phase. Increasing accuracy of the parametrically derived estimates and increasing costs of producing bottoms up estimates should also enhance their uses here.

4. Production, Fielding/Deployment & Operational Support

The final phase described in DoD Regulation 5000.2-R is the Production, Fielding/Deployment & Operational Support phase (PF/D&OS). In this phase, production of the equipment, system or software is begun, and the operational use of the product starts. Application of parametric cost estimates in this phase have been restricted. One such use may be in verifying that the program is tracking with earlier cost estimates by comparing them with actual production costs. Responses to this question concentrate on very useful, 52 responses and some use, 70 responses. The average response value was 2.63 and the median value of 3 or the some use descriptor from the scale used. There were no noteworthy group data for this question. The regression analysis

$$Y = \underset{(.09)}{.206}(X) - \underset{(2.59)}{3.20} \qquad R^2 = .024$$

shows a positive relationship between the responses and the experience level of the participants. The relationship between experience and the data is weak although it does support the idea that the experienced groups in the acquisition community view the methods as having limited use in the PF/D&OS phase. Few areas of application can effectively use parametric cost estimating methods in the PF/D&OS phase. Actual costs of production and the application

of the learning curve concept over the number of units produced are the major cost estimating methods used. Parametric cost estimating methods have little role to play and are unlikely to take on greater prominence in this area in the future.

The response analysis fits the pattern of use for parametric cost estimating shown in Figure 1. The participants as a group believe that the methods have some applications in the CE phase, most utility in the PD&RR and E&MD phases and the least utility in the PF/D&OS phase. The groups with the most experience using the techniques are also the strongest proponents of their utility in the PD&RR and E&MD phases. Future improvements to the techniques that increase their accuracy and flexibility should combine with the discretion given to decision makers to make sound business decisions to increase the uses of parametric cost estimating techniques in all of the program life cycle phases.

C. CONTRACT TYPE

Ideally, contract type is directly tied to the risk inherent in a particular contract situation. These situations are in part formed as a function of the program life cycle stage that the procurement represents. Figure 1 relates the cost risk to the program stages over time. The narrowing cost uncertainty band can be interpreted as declining cost risk as

one progresses through the life cycle of a program. The contract vehicles typically used in each stage also progress from ones that place greater risk on the buyer in earlier phases to ones that shift the burden of risk to the producer in the later stages of the program. A contract type pattern of use throughout a program might be described as [Ref 41]:

- Phase 0 - CPFF
- Phase I - CPIF
- Phase II - FPIF or CPAF
- Phase III - FPIF or FFP

One of the goals of program planning is to match the contract vehicle to the risks in each procurement in each phase of the program. Figure 8 describes a relationship between contract type, risk, and the utility of parametric cost estimating methods.

Question three is divided into segments reflecting each contract type depicted in Figure 8. The response data for each contract type segment will be examined to determine the relationship between this theoretical presentation and the reality of the acquisition environment. Group data will be presented for the control, program manager, industry, and contracting officer groups for each contract type. These groups have extensive knowledge about and experience with

using various contract types in different procurement situations.

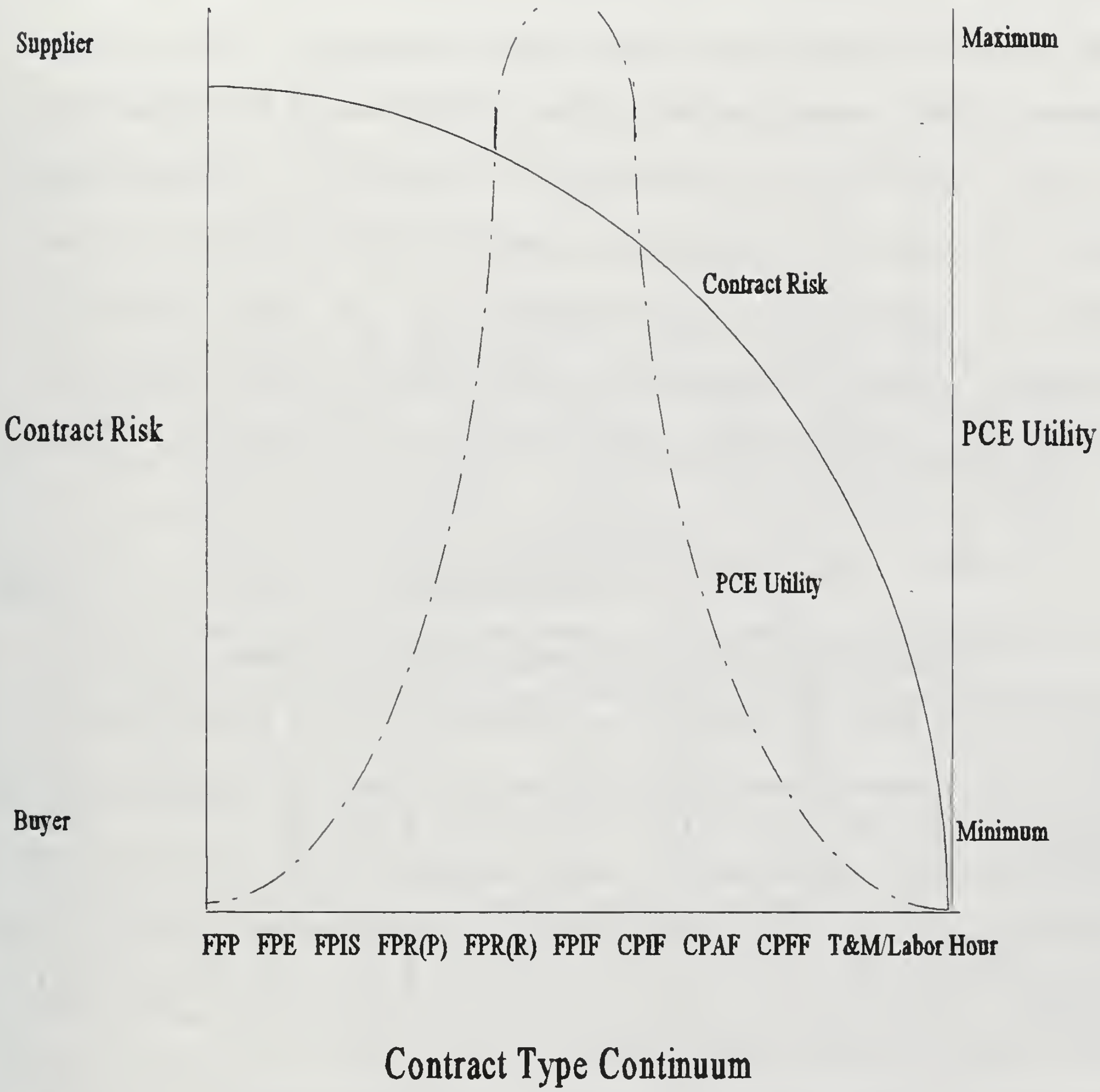


Figure 8: Contract Risk Compared With PCE Utility

Source: Developed by researcher.

1. Firm Fixed-Price

Fixed-Price contract arrangements of all types represent the majority of contracts written. [Ref 39:p.310] In 1994,

these contracts made up 75% of the contracts written by DoD. [Ref 45:p.81] Some use was the median descriptor response to the question of the utility of parametric cost estimating methods to Firm Fixed-Price (FFP) type contracts. This answer was chosen by 60 participants in the survey while 55 chose the very useful descriptor to describe the utility. Analysis of variance of the DoD components supports this opinion of the utility of parametric cost estimating in FFP contract situations. Table 24 contains group data for this question and Table 25 contains the analysis of variance data.

Table 24
FFP Contract Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	5.00	2.00	2.00	1.32	1.00	2.50
Program Managers	1.00	3.00	2.33	2.00	.82	1.75	3.00
Industry	1.00	5.00	2.05	2.00	1.13	1.00	3.00
Contracting Officers	1.00	4.00	2.58	3.00	.87	2.00	3.00

Source: Developed by researcher.

The U.S. Army, DCAA, U.S. Navy, and USAF groups, totaling 105 respondents, had average response values significantly higher than the average. The groups identified in Table 24, however, make decisions about which type of contract to use in situations that they are presented with and thus may have more

influence in this area. Although there is not a consensus across the groups or within any one group, with the exception of the contracting officers, the group averages are somewhat lower than the average for the entire database (2.56). This demonstrates a view that the methods are very useful in FFP contracts.

Table 25
Analysis of Variance For FFP Contract Data

DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	9.99	1.66	2.31	.04
Within Groups	130	93.77	.72		

Source: Developed by researcher.

2. Fixed-Price With Economic Price Adjustment

Responses to the question of the utility of Fixed-Price With Economic Price Adjustment (FPE) type contracts was primarily that they had some use. The average response value was 2.71 and there was a median value of 3 to this question. There were also a large number (81) of no responses. The USAF respondents had a consensus that they were only of some use in these contract situations. Data from the group analysis is presented in Table 26. The benchmark group responses reflect a higher regard for the use of the methods in situations where one would use FPE contracts than did the entire pool of participants.

Table 26
FPE Contract Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	5.00	2.14	2.00	1.46	1.00	3.00
Program Managers	1.00	3.00	2.25	2.50	.96	1.25	3.00
Industry	1.00	5.00	2.00	2.00	1.19	1.00	3.00
Contracting Officers	1.00	4.00	2.77	3.00	.81	2.00	3.00
USAF	2.00	4.00	2.93	3.00	.62	2.75	3.00

Source: Developed by researcher.

3. Fixed-Price Incentive, Successive Target

The aggregate group response to this question was one of some use for the methods in situations that a Fixed-Price Incentive, Successive Target (FPIS) contract arrangement was suitable. This question had a large number (83) of no responses but of those who did answer, 59 selected some use, and 42 selected very useful as their answers. This produced an average response value of 2.62 and the median of 3. Aside from the benchmark groups, the only group with any type of consensus on this question was the Government policy group. These participants also felt strongly that the methods were only somewhat useful in FPIS situations. The contracting officers also echoed this belief while the other benchmark

groups felt that the methods were very useful in these contract situations. Table 27 presents this information.

Table 27
FPIS Contract Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	3.00	1.83	1.50	.98	1.00	3.00
Program Managers	1.00	3.00	2.20	2.00	.84	1.50	3.00
Industry	1.00	4.00	1.95	2.00	.97	1.00	3.00
Government Policy	2.00	4.00	2.81	3.00	.68	2.00	3.00
Contracting Officers	2.00	4.00	2.72	3.00	.67	2.00	3.00

Source: Developed by researcher.

4. Fixed-Price With Prospective Redetermination

Parametric cost estimating methods have essentially the same utility value in Fixed-Price With Prospective Redetermination (FPR(P)) contracts as they do in FPIS contract situations. The aggregate response average was 2.60 with the median value equal to 3 or some use. Again there were a large number of no responses (77) and the distribution was positively skewed. Analysis of variance showed that the NASA respondents thought that the methods were more useful than did the DoD component groups. The data are presented in Tables 28 and 29.

Table 28
FPR(P) Contract Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	3.00	1.83	1.50	.98	1.00	3.00
Program Managers	1.00	3.00	2.20	2.00	.84	1.50	3.00
Industry	1.00	4.00	1.90	2.00	.94	1.00	3.00
Contracting Officers	2.00	4.00	2.74	3.00	.67	2.00	3.00
Government Policy	1.00	4.00	2.68	3.00	.78	2.00	3.00
NASA	1.00	2.00	1.67	2.00	.59	1.00	2.00

Source: Developed by researcher.

Table 29
Analysis of Variance For FPR(P) Contract Data

DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	8.32	1.39	2.69	.02
Within Groups	109	56.19	.52		

Source: Developed by researcher.

Government policy and contracting officer groups differ in their opinion of the utility of the methods to these type of contract situations. Both of these groups believe that parametric cost estimating methods have limited use in FPR(P) contract situations while the remaining groups in Table 28 believe that they are very useful.

5. Fixed-Ceiling-Price With Retroactive Redetermination

The results from the analysis of Fixed-Ceiling-Price With Retroactive Redetermination FPR(R) contract type question mirror those of the FPR(P) question. The composite group response average was 2.64 with the median value equal to 3 or some use. There were a large number of no responses (79) and the distribution was positively skewed. The control, program manager, and industry groups thought that the methods were very useful in these types of contract situations as did the NASA participants. These data are presented in Table 30.

The analysis of variance for DoD component and job classification, presented in Table 31, highlighted not only the NASA group but also the cost estimators, auditors, and cost and price analysts. The last three groups listed believed, as do the contracting officers, that parametric cost estimating methods have only some use in FPR(R) contracting arrangements. The opinion of these groups is significant. They represent a major part (107) of the participants and a cross section of acquisition community who might be expected to be involved in applying the methods to a FPR(R) situation.

Table 30
FPR(R) Contract Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	3.00	1.67	1.50	.82	1.00	2.25
Program Managers	1.00	3.00	2.00	2.00	.71	1.50	2.50
Industry	1.00	4.00	1.84	2.00	.96	1.00	3.00
Contracting Officers	2.00	4.00	2.76	3.00	.71	2.00	3.00
NASA	1.00	2.00	1.67	2.00	.58	1.00	2.00
Cost Estimators	1.00	4.00	2.67	2.00	1.21	1.75	4.00
Cost or Price Analysts	1.00	4.00	2.71	3.00	.90	2.00	3.00
Auditors	2.00	4.00	2.80	3.00	.71	2.00	3.00

Source: Developed by researcher.

Table 31
Analysis of Variance For FPR(R) Contract Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	14.12	1.57	2.41	.02
Within Groups	118	76.76	.65		
DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	8.87	1.48	2.62	.02
Within Groups	108	61.08	.57		

Source: Developed by researcher.

6. Fixed-Price-Incentive, Firm

Group responses to this question were almost evenly divided between some use (57) and very useful (52). The median response was some use and the mean response value was 2.56. Tables 32 and 33 show the information for this question.

Table 32
FPIF Contract Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	3.00	1.63	1.50	.74	1.00	2.00
Program Managers	1.00	3.00	2.33	2.00	.82	1.50	2.50
Industry	1.00	4.00	1.90	2.00	.97	1.00	3.00
Contracting Officers	2.00	4.00	2.64	3.00	.68	2.00	3.00
Cost or Price Analysts	1.00	4.00	2.64	3.00	.90	2.00	3.00
Auditors	2.00	4.00	2.71	3.00	.69	2.00	3.00

Source: Developed by researcher.

The control and industry groups felt that the methods had more utility for Fixed-Price-Incentive, Firm (FPIF) contracts than the other groups that were surveyed. These two groups indicated that the methods were very useful while the remaining groups felt that they had only limited applicability. The analysis of variance data indicate that cost and price analysts, contracting officers, and auditors

(99 of the respondents) thought that parametric cost estimating methods had only some use.

Table 33
Analysis of Variance For FPIF Contract Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	16.98	1.89	2.97	.00
Within Groups	127	80.61	.64		

Source: Developed by researcher.

7. Cost-Plus-Incentive-Fee

Cost-Reimbursement type contracts formed a significant part (18%) of the contracts awarded by the DoD in 1994. [Ref 45:p.81] Parametric cost estimating method utility in Cost-Plus-Incentive-Fee (CPIF) contract situations was determined to be somewhat useful by the survey respondents. An average response value of 2.62 and median of 3 was observed. Contract negotiators, program managers, industry respondents, and engineers (37 participants total), identified in the analysis of variance data, thought that the methods would be very useful in CPIF contract situations. The remainder of the respondents (103), represented in Table 34 by the contracting officer group, thought that the methods were of only some use in this type of situation. It is of interest to note the difference of opinion regarding the utility of parametric cost estimating methods in CPIF situations between the contracting

officers and contract negotiators. One would expect to find similar responses to this question from these two groups because of their common training and experience. Analysis of variance data are presented in Table 35.

Table 34
CPIF Contract Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	2.00	1.50	1.50	.54	1.00	2.00
Program Managers	1.00	3.00	1.80	2.00	.84	1.00	2.50
Industry	1.00	4.00	1.80	1.00	1.15	1.00	2.75
Negotiators	1.00	2.00	1.50	1.50	.58	1.00	2.00
Engineers	1.00	2.00	1.63	2.00	.52	1.00	2.00
Contracting Officers	1.00	4.00	2.71	3.00	.80	2.00	3.00

Source: Developed by researcher.

Table 35
Analysis of Variance For CPIF Contract Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	21.03	2.34	3.41	.00
Within Groups	131	89.79	.69		

Source: Developed by researcher.

8. Cost-Plus-Award-Fee

The median value of 3 reflects the choice of some use by 55 participants to describe the utility of parametric cost

estimating methods to Cost-Plus-Award-Fee (CPAF) contract situations. The average response value was slightly lower at 2.59, in large part due to 43 respondents selecting very useful as their answer to the question. The analysis of variance data showed a clear separation of opinion regarding the utility of the methods to CPAF contract situations. Contract negotiators, program managers, and engineers (17) answered that they were very useful and all of the remaining job classification groups (123) had the opinion that they were only somewhat useful.

The analysis of variance information from the DoD component groups showed that the USAF had the lowest response average and the U.S. Army had the highest average in those groups. The data in Table 36 show that the USAF indicates that the methods are very useful and the U.S. Army only of some use in CPAF contract situations. Analysis of variance information is presented in Table 37. The divergence between contracting officer and contract negotiator opinions regarding this contract type and parametric cost estimate utility observed in earlier questions is also noted here. Also noteworthy is the consensus that the control and engineer groups have on the question. They both believe that the methods are very useful or vital in a situation where one would use this type of contract.

Table 36
CPAF Contract Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	2.00	1.50	1.50	.54	1.00	2.00
Program Managers	1.00	3.00	1.80	2.00	.84	1.00	2.50
Industry	1.00	4.00	1.80	1.00	1.15	1.00	2.75
Engineers	1.00	2.00	1.57	2.00	.54	1.00	2.00
Contract Negotiators	1.00	3.00	1.80	2.00	.84	1.00	2.50
U.S. Army	1.00	4.00	2.82	3.00	.83	2.00	3.25
USAF	1.00	4.00	2.13	2.00	.99	1.00	3.00
Contracting Officers	1.00	4.00	2.72	3.00	.78	2.00	3.00

Source: Developed by researcher.

Table 37
Analysis of Variance For CPAF Contract Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	20.26	2.25	2.93	.00
Within Groups	129	98.98	.77		
DoD Category	DF	Σd^2	σ^2	F	P
Between Groups	6	13.76	2.29	3.06	.01
Within Groups	117	87.69	.75		

Source: Developed by researcher.

9. Cost-Plus-Fixed-Fee

There were no groups that displayed a consensus or unanimous opinion regarding the use of parametric cost estimating methods in situations that would also benefit from the use of a Cost-Plus-Fixed-Fee (CPFF) arrangement. Of the benchmark groups, only the control and contracting officer groups had a consensus of some sort on this question. Table 38 contains only the question three benchmark groups for analysis.

Table 38
CPFF Contract Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	2.00	1.38	1.00	.52	1.00	2.00
Program Managers	1.00	3.00	1.80	2.00	.84	1.00	2.50
Industry	1.00	4.00	1.65	1.00	1.13	1.00	2.00
Contracting Officers	2.00	4.00	2.69	3.00	.79	2.00	3.00

Source: Developed by researcher.

The aggregate group average response to this question was 2.58 and a median response of somewhat useful was recorded. The control group had the highest regard for using the methods in CPFF contract situations, very useful or vital, and the contracting officers the lowest regard for their use in CPFF instances. In comparison with the average value for the entire database, the control, program manager, and industry

groups had a much higher regard for the utility of parametric cost estimating techniques in CPFF contracting than did any other group.

10. Time & Materials

While Time & Materials (T&M) contracts make up only a small percentage (6% in FY 94) of the contracts awarded by the DoD, a significant dollar value is contracted using this vehicle. [Ref 45:p.81] The majority of the responses to this question were divided between some use and no use in an area that a T&M contract might also be beneficial. The largest number of respondents chose some use (53) as their answer and 49 participants chose 4, or no use to the question. The average response value of 3.13 and median response of 3 indicates that the participants felt that the methods were of limited use in these situations. A relatively insignificant number (6) of people chose to respond that the methods would be a hindrance in situations requiring a T&M contract.

The benchmark group data and groups identified during the analysis of variance are shown in Table 39. Table 40 contains analysis of variance results for review. With the exception of the program managers, there is an almost universal belief that the methods have little application in T&M contracting situations. Program staff opinion differs from the program managers in their belief about the utility of the methods

here. Program staff respondents are unanimous in their opinion that parametric cost estimating methods are of no use in T&M contract situations while program managers indicate that they believe that they have some use in the process. The groups shown in Table 39 show a belief throughout the DoD acquisition community that the methods are of little use in T&M situations.

Table 39
T&M Contract Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	5.00	3.29	3.00	1.50	2.00	5.00
Program Managers	1.00	4.00	2.33	2.50	1.21	1.00	3.25
Program Staff	4.00	4.00	4.00	4.00	.00	4.00	4.00
Industry	1.00	5.00	2.90	3.00	1.37	2.00	4.00
Cost or Price Analysts	1.00	5.00	3.27	3.00	1.03	3.00	4.00
Contracting Officers	2.00	5.00	3.15	3.00	.82	2.75	4.00

Source: Developed by researcher.

Table 40
Analysis of Variance For T&M Contract Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	17.21	1.91	2.31	.02
Within Groups	128	105.89	.83		

Source: Developed by researcher.

11. Labor Hour

The results of the analysis of the Labor Hour contracts, representing 1% of all DoD procurement actions, are similar to those of the T&M contracts. [Ref 45:p.81] Again, there was a median response of only some use and an average value of 3.13. Responses from the benchmark groups in Table 41 reflect a view that the methods have little application in this type of contract environment. The program staff group is unanimous in their opinion that the methods have no use in labor hour contract type situations. This differs slightly from the view of the program managers who see some application for parametric cost estimating methods in labor hour contracts.

Table 41
Labor Hour Contract Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	5.00	3.50	4.00	1.76	1.75	5.00
Program Managers	2.00	4.00	3.00	3.00	.71	2.50	3.50
Program Staff	4.00	4.00	4.00	4.00	.00	4.00	4.00
Industry	1.00	5.00	3.11	3.00	1.28	2.00	4.00
Contracting Officers	2.00	5.00	3.11	3.00	.87	2.00	4.00

Source: Developed by researcher.

The analysis of the various contract types indicates that there are some contract types that can benefit through applying parametric cost estimating methods to the process more than others. The average values for the control, program manager, and industry groups indicate a relationship between risk, contract type, and the utility of parametric cost estimating methods similar to that shown in Figure 8. Respondents in these groups viewed the methods as having the most applicability in CPFF and least utility with T&M or labor hour contract situations. While this relationship exists, it may not be as pronounced as that shown in Figure 8. Furthermore, the relationship shows a distribution of utility that is skewed to the right. Figure 9 graphically displays the average values for the various contract types.

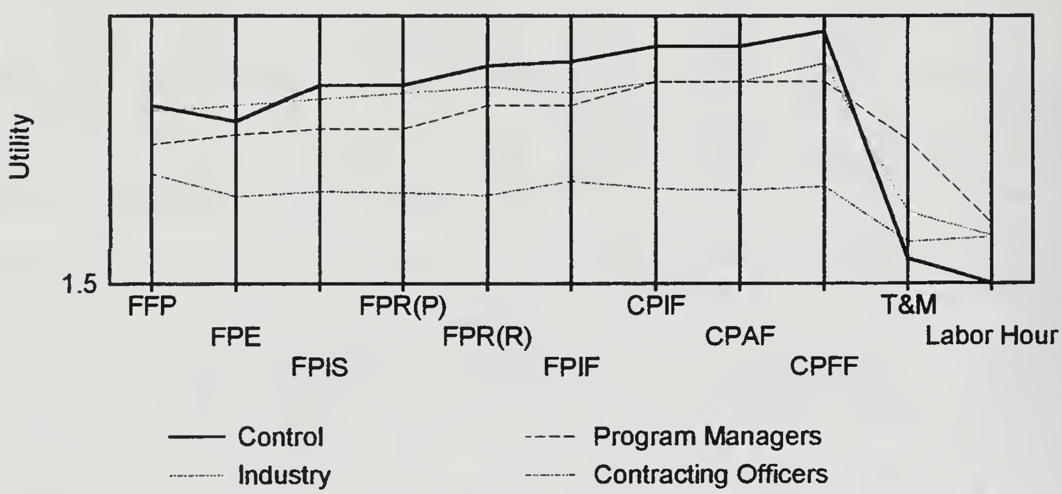


Figure 9: Contract Type Compared to Parametric Cost Estimating Utility

Source: Developed by researcher.

The increase observed in the utility lines for the control, program manager, and industry groups is not present in the contracting officer line. The contracting officers may view risk from an individual contract standpoint rather than across an entire program. They may see parametric cost estimating as a tool to be evaluated for use in one single action and not having any relationship to risks in the contract or program. This group is also made up of a combination of procuring contracting officers (PCO) as well as administrative contracting officers (ACO). These two subgroups may have different viewpoints on the utility of the methods based on risk and contract type that are masked when they are combined into one group. These differences could be a result of the roles both groups have in the acquisition process and program management cycles.

All of the benchmark groups for this question responded that there was little or no application for parametric cost estimating methods in either T&M or labor hour contract situations. This type of contract is usually used in situations where the work can be described but not the quantity of work needed. Pricing for the labor or materials is performed by determining actual labor rates or material costs based on the marketplace. These two factors combine to make parametric cost estimating methods less efficient in

these situations than other estimating methods. However, the methods should be able to provide some use if adequate databases and analysis techniques are available to project the required quantities of labor or materials.

D. PRE-AWARD & POST-AWARD CONTRACT ACTIONS

Question four asks the participants to offer an opinion on the utility of parametric cost estimating methods to either pre-award actions or post-award actions. Pre-award activities where parametric cost estimating might be useful include budgeting, ICE generation, proposal analysis, or preparing for negotiations and price analysis. Post-award actions in which the methods may be useful could include evaluating an Engineering Change Proposal (ECP), analyzing the cost aspects of a claim, negotiating a Forward Pricing Rate Agreement, or negotiating changes to existing contracts. These actions could be performed by either PCO or ACO personnel at various points in the acquisition process.

1. Pre-Award Contract Actions

Pre-award functions such as those previously described are the areas in which parametric cost estimating methods are usually thought to apply most directly. Given this pre-disposition it is not surprising to find that the responses show a relatively high degree of utility for the methods in pre-award contract actions. The average response value for

this question is 2.36 and the median value is 2 or very useful. All of the responses were coded 4 or lower indicating that no one felt that the methods were a hindrance in pre-award actions. Also, only 13 responses were coded as no use for the methods in pre-award applications. Tables 42 and 43 present the group data and analysis of variance data for this question.

Table 42
Pre-Award Contract Action Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Staff	3.00	3.00	3.00	3.00	.00	3.00	3.00
Control Group	1.00	1.00	1.00	1.00	.00	1.00	1.00
Corporate Policy	1.00	2.00	1.60	2.00	.55	1.00	1.50
Program Managers	1.00	3.00	1.57	1.00	.79	1.00	2.00

Source: Developed by researcher.

Table 43
Analysis of Variance For Pre-Award Action Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	12.16	1.35	1.94	.05
Within Groups	161	111.88	.90		

Source: Developed by researcher.

All of the job classification groups think that parametric cost estimating methods are useful in pre-award actions but the analysis of variance data highlighted the program staff and program manager groups. These two groups have a significant difference of opinion regarding the utility of the methods. The program managers believe that parametric cost estimating methods are vital or very useful in pre-award situations while the program staff are unanimous in their belief that the methods are only of some use. The control group also is unanimous in their opinion. They feel that the methods are vital to pre-award actions. Another group of interest, the corporate policy group, feels that parametric cost estimating methods are very useful in these actions. This is also represented in the regression equation that relates business size to the responses. This equation

$$Y = \underset{(.15)}{.351}(X) - \underset{(2.03)}{6.56} \qquad R^2 = .21$$

indicates that there is a negative relationship between business size and the response to this question. As business size increases the respondents believe that the methods are more applicable in pre-award contract actions. This might be expected as the larger businesses have more experience with using the methods than the smaller ones do. With this strong response, the use of parametric cost estimating methods should continue to be used extensively in pre-award contract actions.

2. Post-Award Contract Actions

Parametric cost estimating methods are not usually associated with post-award contract actions. Often other cost or pricing analysis techniques based on costs experienced up to that point in the contract are used to price changes, modifications, claims, or other post-award actions. The responses to this question reflect a view that the methods have little use in post-award contract actions. The answers were almost equally divided between some use (59) and no use (53) producing an average response value of 3.04 and median response of some use. A relatively insignificant number (8) of respondents felt that the methods could actually hinder post-award contract actions.

Analysis of variance data showed a relationship between the responses and the DoD component and job classification groups. These data are presented in Table 45. Group data are presented in Table 44. From the analysis of variance, it was noted that the control group found the methods to be vital or very useful in post-award contract actions as well as in pre-award contract actions. Program managers and NASA respondents agreed with the control group in believing that the methods were very useful in these activities. The DCAA participants felt that parametric cost estimating had little if any utility in post-award contract actions.

The NASA response and their long history of involvement with parametric cost estimating offers the potential for greater use in this area. This group believes that the methods are applicable in certain post-award contract actions as do the program managers and the control group. The methods should provide the same benefits to a post-award negotiation or acquisition plan review that they do in preparing for negotiations in the pre-award phase or in drafting an acquisition plan.

Table 44
Post-Award Contract Action Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	2.00	1.23	1.00	.35	1.00	1.00
Program Managers	1.00	3.00	2.14	2.00	.90	1.00	3.00
NASA	1.00	4.00	2.50	2.50	.93	1.00	4.00
DCAA	2.00	5.00	3.75	4.00	.73	3.00	4.00

Source: Developed by researcher.

The DCAA group response has the highest value of any of the DoD component or job classification groups. Where the program managers are at least one level removed from documenting a post-award agreement, the DCAA and contracting officer groups are the individuals who bring it to fruition. Their belief that the methods are of little use in post-award

actions is a strong counter to the control and program manager groups' drive to use the methods in post-award contract activities.

Table 45
Analysis of Variance For Pre-Award Action Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	8	29.63	3.70	3.96	.00
Within Groups	154	143.95	.94		
DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	29.60	4.93	5.81	.00
Within Groups	140	118.80	.85		

Source: Developed by researcher.

E. SUMMARY

Questions one through four attempted to bring someone participating in the survey through a process of identifying that person's underlying beliefs about where parametric cost estimating could be used. The opinions presented in these questions address the basic research question of:

> How could a DoD emphasis on using parametric methods in cost estimating affect the procurement process?

The responses of the participants form the foundation of the analysis of the remaining questions as they address specific subsidiary research questions.

The remaining questions, five through ten, ask the respondent to address issues regarding the application of the methods to specific contract actions. The last five questions use a five point scale of agreement or disagreement with each statement. A response of one or two indicates agreement and those of three or four show disagreement. A response of five is coded as no opinion.

VII. ACQUISITION AND SOLICITATION PLANNING

A. PURPOSE

The purpose of this chapter is to analyze the responses to questions five and six. These two survey questions and the first four interview questions address planning areas that may be impacted if parametric cost estimating methods are used. Questions five through ten used a five point scale indicating the degree of agreement with a set of statements within each question presented. The scale ran between "strongly agree," a one on the scale, to "strongly disagree," a four on the scale, with a five on the scale being "no opinion" regarding the question. For questions five through ten, a "no response" was coded the same as a "no opinion" response as it was entered into the database.

B. METHODS, MODELS, AND SOFTWARE

Question five is a six segment series of statements to which the respondents indicated that they agreed or disagreed. The statements are directed at answering the first subsidiary research question,

> What changes could offerors make to their proposal preparation, submission and support processes to accommodate using parametric methods, techniques, or software in estimating potential contract costs?

Responses to each statement will be analyzed in the same manner used in the background questions. A discussion of each

statement's purpose will be followed by group data analysis and presentation of the data.

1. Acquisition Streamlining

Question 5a asks respondents to provide their opinion regarding the following statement:

> Parametric cost estimating methods, models, and software could eventually replace traditional bottoms up cost estimating methods in many acquisition estimating applications as a result of acquisition streamlining.

Many acquisition streamlining initiatives are based on the principle that business is more efficient in its use of resources than is the Federal Government. This statement addresses the potential displacement of traditional estimating methods by parametric cost estimating methods. The statement is directed at determining if acquisition streamlining will accelerate this process. The effects of parametric cost estimating replacing the traditional methods are addressed in later questions.

The aggregate response to this question was one of indecision. An average response value of 2.49 was calculated from a response distribution of 1(28), 2(62), 3(67), and 4(28). This distribution produced a median value of 3 or disagreement with the statement. The program staff response, shown in Table 46, is very clearly disagreeing with the statement. This group does not believe that traditional cost

estimating methods will be supplanted by parametric cost estimating methods.

There are other groups shown in Table 46, however, that do believe that the methods could eventually replace traditional methods in some applications. Engineers and those who set corporate policy believe that parametric cost estimating methods could be used in many more applications as the primary estimating method. Greater discretion given to decision makers could result in the methods being applied in more situations.

Table 46
Question 5a Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Staff	3.00	4.00	3.75	4.00	.50	3.25	4.00
Engineers	1.00	3.00	2.00	2.00	.63	2.00	2.00
Corporate Policy	1.00	2.00	1.40	1.00	.55	1.00	2.00

Source: Developed by researcher.

Figure 10 depicts a situation where a precise but time-and-cost-intensive detailed estimate and a somewhat less precise but quicker and less costly parametric estimate are compared at the same point in the acquisition cycle. [Ref 40] Both estimates predict the cost of the equipment will cost between $79 and $140. The detailed estimate provides a higher

probability that it will cost $105 than any other price in the estimate range. In some situations, the use of good business judgment will require a program manager or contracting officer to use the less precise estimate.

In the past the acquisition community has relied heavily on precise, detailed estimates often contributing to program delays and added costs. Encouraging acquisition officials to make these types of decisions based on sound business practices is a critical part of acquisition streamlining. Parametric cost estimating is one of the tools available to analyze situations and make decisions based on good business judgment.

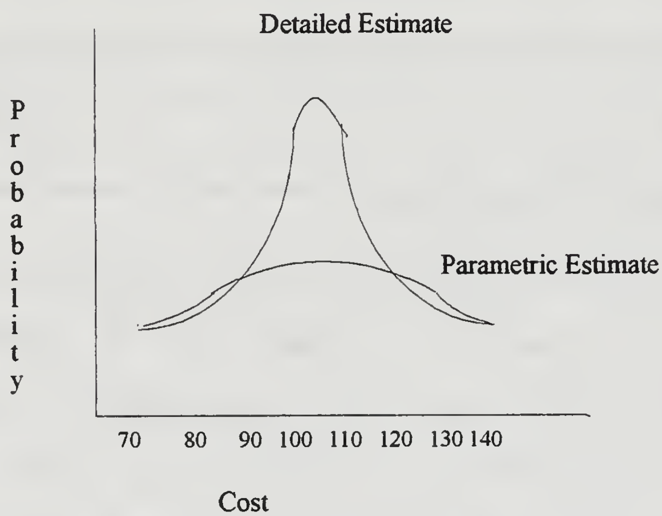


Figure 10: Estimate Accuracies

Source: Shields, October 1996

2. Information Systems Improvements

Through statement 5b, the survey participants are asked to consider how technology might affect the cost estimating methods that are being used.

> Parametric cost estimating methods, models, and software could replace traditional cost estimating methods as larger, more compatible data bases, greater computing power, and improved software become available.

Parametric cost estimating methods can be computer asset intensive and improvements in either hardware, software, or database management could have dramatic effects on their precision. The participants in the survey agreed with the statement that improvements in computer capability could allow parametric cost estimating methods to supplant more traditional methods. An average response value of 2.38 and median response of agreement or 2 were observed for this question. The corporate policy group was unanimous in their agreement to this statement. They had an average response of 1.40 and standard deviation of .548 and everyone in this group agreed or strongly agreed.

Technology advances could potentially change the characteristics for the Figure 10 parametric cost estimate to more closely match those of the detailed estimate. While the performance of parametric cost estimating systems might improve with computer technology, advancements there might

also benefit traditional methods. The same increasing computer capability that could make parametric cost estimating more precise could also be used to make bottoms up estimating more accurate. [Refs 20,30] Greater connectivity between data gathering systems could reduce the cost of producing a detailed estimate just as it may make parametric cost estimating more accurate and faster. The corporate policy group response indicates greater acceptance for using parametric cost estimating methods in future applications, however.

3. Advantages

The concepts in the following statement provide the motivation for both contractor and Federal Government personnel to use parametric cost estimating methods in more areas:

> Parametric cost estimating methods, models, and software can save contractors and Federal Government oversight officials significant time and expense in developing and then evaluating proposals.

The majority (142) of the survey participants agreed with this statement. The median response was 2 and the average response value observed was 2.04. The group data presented in Table 47 show a range of activities across the acquisition community that believe that parametric cost estimating methods have the potential to speed up the acquisition process and reduce the

costs of proposal preparation and evaluation. The control, engineer, and corporate policy groups strongly feel that these methods can provide the advantages listed. This indicates that there is a willingness to use the methods on a wider basis. The belief and acceptance by DCAA of the potential that the methods could lead to greater acceptance for using the methods in more areas where traditional cost estimating methods have been used.

Table 47
Question 5c Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	2.00	1.27	1.00	.47	1.00	2.00
Engineers	1.00	2.00	1.45	1.00	.52	1.00	2.00
Cost Estimators	1.00	3.00	2.00	2.00	.77	2.00	2.00
Corporate Policy	1.00	2.00	1.20	1.00	.45	1.00	1.50
DCAA	1.00	4.00	2.15	2.00	.62	2.00	2.00

Source: Developed by researcher.

4. Data Collection

Question 5d asks the participants to record their opinions about the following statement:

> Parametric cost estimating methods, models, and software could significantly change the way potential contractors collect and summarize cost information.

Many cost collection systems primarily used by Federal Government contractors are designed or have been modified to collate information to support invoicing. In addition to providing management information, one of their secondary functions is to provide data for their cost estimating systems. Data available from these systems form the databases from which parametric cost estimates may be produced. This statement addresses the concern that these systems may not be ideally suited for producing information to be used in parametric cost estimating systems.

The participants agreed with the statement that parametric cost estimating could affect the way cost data are collected and presented. A median value of 2 and an average response of 2.14 were noted. An analysis of variance performed on the DoD component response data showed that the NASA and USAF groups felt more strongly in agreement with this question than any of the other groups. The remaining DoD component groups were clustered around simple agreement with the statement. Within the USAF group, the USAF cost analysts were notable for their strong belief that the methods could change the way cost data were collected and summarized. Group response and analysis of variance data are presented in Tables 48 and 49.

Table 48
Question 5d Group Data

	Min	Max	μ	Median	σ	Q1	Q3
USAF Cost Analysts	1.00	2.00	1.43	1.00	.54	1.00	2.00
Corporate Policy	1.00	2.00	1.20	1.00	.45	1.00	1.50
USAF	1.00	3.00	1.71	2.00	.59	1.00	2.00
NASA	1.00	3.00	1.50	1.00	.76	1.00	2.00

Source: Developed by researcher.

Table 49
Analysis of Variance For Question 5d Data

DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	6	12.98	2.16	4.05	.00
Within Groups	152	81.17	.53		

Source: Developed by researcher.

5. Cost Overruns

Most of the survey participants disagreed with the following statement:

> Parametric cost estimating methods, models, and software should decrease the probability of cost overruns where used.

A total of 110 respondents disagreed with the statement which produced a mean response value of 2.89 and disagree (3) response for the median. The analysis of variance on job classification responses showed almost overwhelming

disagreement with the statement. The auditor group data in Table 50 represents that view.

Two groups in the analysis of variance were noteworthy because of their agreement with the statement. Table 51 contains the analysis of variance data. The program manager and engineer groups feel that parametric cost estimating methods may have some use in preventing cost overruns.

Table 50
Question 5e Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Auditors	2.00	4.00	3.97	3.00	.67	2.75	3.00
Engineers	1.00	3.00	2.00	2.00	.55	2.00	3.00
College Algebra	2.00	4.00	3.00	3.00	.66	3.00	3.00
Program Managers	1.00	4.00	1.86	2.00	1.07	1.00	2.00

Source: Developed by researcher.

Table 51
Analysis of Variance For Question 5e Data

Job Classification	DF	Σd^2	σ^2	F	P
Between Groups	9	16.89	1.88	3.17	.00
Within Groups	145	85.84	.59		

Source: Developed by researcher.

There is also a relationship between mathematics education and the responses that supports the group data in Table 50. The regression equation

$$Y = -.094(X) + 6.40 \qquad R^2 = .02$$
$$\quad (.04) \qquad (1.66)$$

indicates a weak negative relationship between the responses and mathematics education. The greater level of mathematics education that both groups have and the experience that the program managers have may have produced this result. These two groups may view the issue of cost in terms of a range of possible costs, similar to that presented in Figure 10, that parametric cost estimating methods may help to define. Given the flexibility to work within that range may provide a way to manage risks to avoid cost overrun situations.

6. Cost and Pricing Data

Given the response to statement 5d, one would also expect a similar response to the following statement:

> Parametric cost estimating methods, models, and software should change the way cost and pricing data submitted to support a proposal is viewed.

Cost and pricing data are "... all the facts that can be reasonably expected to contribute to the soundness of estimates of future costs." [Ref 13:part 15.801] If the methods used to collect and summarize data are changed by a potential contractor then it is reasonable to assume that the cost and pricing data that the company submits to the Government in a proposal will also change.

The average response to this statement was agreement. An aggregate group average of 2.29 and a median value of 2 was noted. A broad cross section of the DoD acquisition community is presented in Table 52 who agree with this statement. Individuals who prepare estimates for both the Federal Government and the DoD contractor community are represented in agreement with the statement.

Table 52
Question 5f Group Data

	Min	Max	μ	Median	σ	Q1	Q3
USAF Contracting Officers	2.00	3.00	2.17	2.00	.41	2.00	2.25
Negotiators	2.00	2.00	2.00	2.00	.00	2.00	2.00
Engineers	1.00	3.00	2.00	2.00	.50	2.00	2.00
Prepare Estimates	1.00	3.00	1.97	2.00	.59	2.00	2.00
USAF	1.00	4.00	2.06	2.00	.77	2.00	2.00

Source: Developed by researcher.

These groups represent individuals who would be expected to receive and then analyze a proposal to a solicitation which could include cost and pricing data. All of the groups listed show a consensus viewpoint. The contract negotiator group is also unanimous in their agreement with the statement.

The responses to this series of statements indicate that the commercial industry component of the DoD acquisition

community is willing to use parametric cost estimating methods. The data also indicate that many in the Federal Government are willing to accept the use of the methods also. To take this step, both parties should agree that the contractor community may have to take several actions. Generating cost estimates based on parametric methods will require investments in software either for database analysis and the generation of models or for the purchase of existing models that can be modified. The benefits that might drive this change would accrue to both Government and industry in the reduced acquisition cycle times, lower cost proposal preparation costs, and greater management flexibility. It will also require some changes to the systems used to collect, collate, and analyze cost data within industry and the Government. For a contractor organization that elects to use parametric cost estimating methods as a primary tool for generating data for contract management, significant changes to his existing structure could be required.

C. SOLICITATION PLANNING

Question 6 addresses the issues raised in the second and third subsidiary research questions in seven parts. The questions it deals with are,

1. What impacts could emphasis on using cost estimates based on parametric cost estimating techniques have on

source selection and on the evaluation of proposals by the DoD? and

2. How could source selection criteria and evaluation factors be constructed to fairly evaluate a proposal that uses a parametric estimate with one that does not?

Providing a level playing field for all solicitation proposals is a primary goal of Federal Government contracting. The statements in this question deal with how the Government can construct that level playing field within the solicitation it issues in regard to the use of parametric cost estimating methods.

1. Encouraging Parametric Cost Estimating Use

The first statement in this question asks the respondent if the Government should simply encourage the use of parametric cost estimating methods.

> In solicitations, buying activities should encourage the use of parametric cost estimating for specified procurement actions.

The majority of respondents overwhelmingly agreed with this statement, 95 individuals selected agree, and 27 selected strongly agree. An average response value of 2.21 and a median value of 2 was shown in the cumulative data. The group data in Table 53 is a display of groups within the DoD acquisition community whose responses are noteworthy for this question.

This diverse group all agree that the proposing organization should be encouraged to use the methods where applicable. As one might expect, the group representing industry is most emphatic in their agreement with this statement. Given the present environment of preference for disengagement from intrusive inspection systems and burdensome requirements, this is the most likely form of emphasis that DoD will use to promote parametric cost estimating techniques.

Table 53
Question 6a Group Data

	Min	Max	μ	Median	σ	Q1	Q3
DCMC Cost Analysts	1.00	3.00	2.07	2.00	.59	2.00	2.00
Negotiators	1.00	3.00	2.00	2.00	.58	2.00	2.00
Corporate Policy	1.00	2.00	1.25	1.00	.50	1.00	1.75
DCMC	1.00	3.00	2.22	2.00	.54	2.00	2.00
Prepare Estimates	1.00	4.00	1.94	2.00	.77	1.00	2.00
USAF	1.00	3.00	1.88	2.00	.62	1.25	2.00

Source: Developed by researcher.

2. Specifying Methods, Models, or Software

Question 6b, shown below, deals with more aggressive use of parametric cost estimating methods by requiring them to be used when the buying organization feels that they would be helpful.

> In solicitations, buying organizations should, specify parametric cost estimating methods, models, or software for cost proposal construction.

The average response to this statement was to disagree. An average summary value was 2.73 and the median value of 3 indicate this sentiment. The three groups whose data are shown in Table 54 all disagree with this statement. All three groups' responses are noteworthy; the control group because of their long study of the appropriate uses of parametric cost estimating methods and both contracting officer groups because of their experience in generating solicitations.

Regression analyses of the GS/SES level and business size responses show a relationship exists. The equations and statistics

GS/SES Level

$$Y = \underset{(.14)}{.286}(X) - \underset{(1.90)}{1.45} \qquad R^2 = .10$$

Business Size

$$Y = \underset{(.20)}{.471}(X) - \underset{(2.72)}{3.71} \qquad R^2 = .03$$

demonstrate positive relationships between responses and increasing Government rank and also increasing business size.

The more senior the respondent the more they disagreed with the statement and the larger the business the more that they disagreed with the statement. It is very clear that neither the Government nor industry wants the Government to specify cost estimating methods to be used in response to a solicitation.

Table 54
Question 6b Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	2.00	4.00	3.18	3.00	.60	3.00	4.00
USN Contracting Officers	2.00	3.00	2.75	3.00	.45	2.25	3.00
USAF Contracting Officers	3.00	4.00	3.17	3.00	.41	3.00	3.25

Source: Developed by researcher.

3. Offeror Discretion in Using Parametrics

Question 6c records participant opinions about the statement that follows:

> In solicitations, buying activities should leave parametric cost estimating methods, models, or software selection to contractor discretion.

Leaving the use of cost estimating methods to be used completely up to the seller's discretion was agreed to by 111 of the respondents. This produced a median value of 2 and an average response value of 2.33. The analysis of variance with

the DoD component data showed a relationship was present in the information. Of the DoD job classification groups only the NASA and USAF groups, 22 participants, clearly agreed with this statement. The data to support this are shown in Tables 55 and 56.

With the exception of the NASA and USAF groups, all of the other job classification groups were split between agreement and disagreement. The DCMC response data in Table 55 is representative of these groups. Unexpectedly, there was also no consensus among the industry participants regarding this statement as there was in statement 6a.

Table 55
Question 6c Group Data

	Min	Max	μ	Median	σ	Q1	Q3
DCMC	1.00	3.00	2.24	2.00	.60	2.00	3.00
NASA	1.00	2.00	1.80	2.00	.48	1.50	2.00
USAF	1.00	3.00	1.88	2.00	.70	1.00	2.00

Source: Developed by researcher.

Table 56
Analysis of Variance For Question 6c Data

DoD Component	DF	Σd^2	σ^2	F	P
Between Groups	9	9.77	1.63	2.57	.02
Within Groups	144	91.20	.63		

Source: Developed by researcher.

4. Required Cost Breakdown Formats

Respondents to question 6d were asked to provide their opinions about how parametrics might change data presentation for solicitations through the following statement:

> In solicitations, buying activities should require a specific cost breakdown format for parametric cost estimate based proposals.

This statement addresses the issues in the question:

> If parametric cost based estimates are used in a proposal, should the buyer state the format that the cost information is to be presented?

With so many different systems producing estimates, some standardization may be helpful in evaluating proposals in a timely manner. A specified cost breakdown format is one method of standardization that is available.

The majority (108) of the respondents agreed to this premise producing an average response value of 2.35 and median response of 2. Analysis of variance on the job classification responses showed that a relationship between the responses and the classifications was present. Tables 57 and 58 contain the data pertinent to the question 6d statement. The auditor, program staff, program manager, and contract negotiator groups, 54 respondents total, all indicated agreement with this statement. These groups might all be part of a source selection team and see a value in having a specified format.

Another significant group in the source selection process, the contracting officers, did not come to a consensus on either agreement or disagreement with the statement, however.

Table 57
Question 6d Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Auditors	1.00	3.00	2.06	2.00	.65	2.00	2.25
Negotiators	1.00	2.00	1.67	2.00	.52	1.00	2.00
DCAA	1.00	4.00	2.06	2.00	.63	2.00	3.00
Contracting Officers	1.00	4.00	2.50	2.00	.73	2.00	3.00
Program Staff	1.00	3.00	2.00	2.00	.71	1.50	2.00
Program Managers	1.00	3.00	1.86	2.00	.69	1.00	2.00

Source: Developed by researcher.

Table 58
Analysis of Variance For Question 6d Data

Job Description	DF	Σd^2	σ^2	F	P
Between Groups	9	11.19	1.24	2.05	.04
Within Groups	159	96.59	.61		

Source: Developed by researcher.

Regression analysis with the GS/SES level and business size group data showed positive relationships in the data. The equations

GS/SES Level

$$Y = \underset{(.14)}{.300}(X) - \underset{(2.01)}{1.91} \qquad R^2 = .10$$

Business Size

$$Y = .484(X) - 4.61 \qquad R^2 = .25$$
$$\quad (.18) \qquad (2.45)$$

describe these relationships. Again, as one's rank or business size increases so does the response value to the question. These results indicate that experience with the methods would lead to allowing the seller discretion in not only their use but in how they choose to present the data from those estimates.

5. Cost and Technical Proposal Relationships

A second area of concern in evaluating proposals is that of having the information in each section correspond to one another. The following statement addresses this issue:

> In solicitations, buying activities should require a specified format to extract labor hours, subcontractor, or material quantity estimates for technical proposal evaluation.

A standard format required by the buyer stating that format could provide that concurrency. Similar results to the 6d statement were observed. An average response value of 2.37 and a median value indicate agreement with the statement by the entire group of participants. The group of contract negotiators had a consensus that they strongly agreed with this statement. Their group response was the only group response to reach any type of consensus of all of the demographic categories identified.

6. Statistical Evaluation Criteria

Determining what criteria will be used to evaluate the validity of the CERs used to produce estimates included in a proposal and stating them in the solicitation is another method of creating a level playing field. Statement 6f, as shown below, examines this area:

> In solicitations, buying activities should state criteria used to evaluate the statistical significance of cost estimating relationships used to support a parametric cost estimating model.

A great deal of agreement was noted for this statement. The average response value was 2.06 and the median value was a 2, largely a result of 137 respondents electing to either agree or strongly agree with the statement. The group data in Table 59 show a wide range of acquisition activities across the entire acquisition community who agree with the statement.

Table 59
Question 6f Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Staff	1.00	2.00	1.50	1.50	.58	1.00	2.00
Cost Estimators	1.00	3.00	1.97	2.00	.55	2.00	2.00
Prepare For Negotiations	1.00	4.00	2.00	2.00	.74	2.00	2.00
Prepare Estimates	1.00	3.00	2.03	2.00	.65	2.00	2.00
USAF	1.00	4.00	2.24	2.00	.66	2.00	2.25

Source: Developed by researcher.

Information regarding CER validity could be interpreted to be required by FAR part 15.406-5 in that it could be defined as a significant factor that might be considered in awarding a contract.

7. Traditional or Parametrics Methods in Solicitations

Statement 6g, show below, asks survey participants their opinion about the concept of fairness in a solicitation if parametric methods are either specified or excluded.

> In solicitations, buying activities should require cost proposals based on either parametric cost estimating methods or traditional methods.

A source selection plan should not favor one proposal over another simply by the way the proposal evaluation plan is constructed. The plan must make sure procedures do not act to exclude or discourage potential offerors from submitting proposals. The statement addresses the problem of fairly evaluating a parametric-based cost proposal with one produced using more traditional detailed methods. Can an evaluation plan be constructed that will fairly evaluate both types of cost estimates or must the buyer specify which an offeror should use because they cannot be evaluated fairly?

There was no agreement on this question at the level of the entire pool of participants nor on an individual group level. The aggregate response average value was 2.55 and a median value of 3 was observed. These data indicate that the

group disagreed in general with the statement but that they were effectively split over agreeing and disagreeing. There were also a significant number (51) of no opinion or no responses to this question.

D. SUMMARY

The results from the analysis of the statements in questions five and six provide a number of areas that could be affected by the use of parametric cost estimating methods. Chief among these areas is the contractor cost estimating system. The systems will respond to the encouragement that the Federal Government members of the DoD acquisition community provides. There was universal agreement that buying activities should encourage the use of parametric cost estimating methods but not require them.

One of the most effective methods of encouraging the use of the methods is in the source selection process. An evaluation of a parametric-based proposal that is viewed by the offeror to be unfair could be taken as discouragement. The trend should remain with telling the offerors what is required and letting them propose methods of achieving that goal. In that regard, source selection plans should be constructed to allow any reasonable type of cost proposal submitted to be fairly evaluated.

Required formats for data submission in terms of the cost proposal or technical proposal were viewed by the group as useful in creating a level playing field. These actions have the advantage of letting the offerors meet the goal that is required rather than telling them how it is to be accomplished. They prevent the Government from dictating specific methods to be used while every offeror has some idea of how the information provided will be used. They have the added benefit of providing some consistency throughout the proposals which speeds up the evaluation process.

If parametric estimating methods are acceptable for use as a basis for a cost proposal, the proposal must state how they will be evaluated when compared with other methods. FAR part 15.605(c)(d)(1) addresses the issue of evaluation factors under which this issue falls.

> ... at a minimum, the solicitation shall clearly state the significant evaluation factors, such as cost or price, cost or price-related factors, past performance and other non-cost or non-price-related factors, and any significant subfactors, that will be considered in making the source selection. [Ref 13:part 15.605]

A buying organization must consider constructing their solicitation to include the possibility of parametric estimate-based cost proposals if all proposals are to be evaluated fairly. The members of the source selection

evaluation board should also consider this issue as cost is always an evaluation factor.

VIII. PROPOSAL ANALYSIS AND NEGOTIATIONS

A. PURPOSE

Chapter VIII is an analysis of the responses to questions seven through ten. These survey questions and the last four interview questions address issues that may arise during the evaluation of a parametric-based proposal and subsequently the negotiations that may result. The four survey question responses were graded along the same five point scale used in questions five and six. With the exception of question nine, all of the questions were a series of statements upon which participants recorded their opinions.

B. COST PROPOSAL SUPPORTING DATA

Question seven is a three part series of statements that again address the first subsidiary research question.

> What changes could offerors make to their proposal preparation, submission, and support processes to accommodate using parametric methods, techniques or software in estimating potential contract costs?

In the three statements for question seven, an offeror has decided to provide a parametric-based cost estimate in response to a solicitation. The question addresses the information that might be submitted to substantiate that estimate. The Government goal in obtaining information about the estimate centers around regenerating that estimate to understand how it was generated, its limitations, and

strengths. Providing data to do this is a vital part of submitting a successful proposal.

1. Software and Input Data

Statement 7a addresses one of the ways that an offeror could chose or be required to provide supporting information for a cost proposal.

> A potential contractor should provide the parametric cost estimating model software and input data used to support a cost proposal.

Providing the software and input data used to produce an estimate is one way to meet the Government goal of being able to reproduce the estimate. Without these tools it cannot be accomplished. There was a strong agreement to this statement in the responses. The response average was 1.81, generated in large part by the large number of people who answered strongly agree (66) and agree (95) to this statement. Responses to this statement also had a small standard deviation (.76) indicating a consensus among the respondents on this statement. The group data in Table 60 provides a sample of the groups that agreed to this statement within the DoD acquisition community.

Agreement to this statement covered the entire spectrum of functional areas that might be tasked to evaluate a cost proposal. All responded that this information should be provided by an offeror in support of a cost proposal. The

industry response to the statement was not as clear. There was no consensus in the industry response as a whole nor in the group that set corporate policy.

Table 60
Question 7a Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Auditors	1.00	4.00	1.65	2.00	.70	1.00	2.00
Cost Analysts	1.00	4.00	1.73	2.00	.72	1.00	2.00
Contracting Officers	1.00	3.00	1.83	2.00	.54	1.50	2.00
Cost Estimators	1.00	3.00	1.83	2.00	.72	1.00	2.00
Engineers	1.00	3.00	1.91	2.00	.70	1.00	2.00

Source: Developed by researcher.

2. Justifying Parametric Use

Beyond providing the software and input data, there should be a supportable reason to use parametric cost estimating methods. They should be applicable to the procurement action in question and the work relatable to the databases used. Shown below, statement 7b examines this issue.

> A potential contractor should provide justification to support the use of parametric cost estimating models and input data in his cost proposal.

The majority of the participants answered that they agreed (107) or strongly agreed (64) with the statement. The average response value was 1.75, a standard deviation of .65 was noted

and agree was the median response. The widespread agreement to this statement includes almost every functional group in the DoD acquisition community. The major functional areas of the community that typically are involved in evaluating proposals are shown from buying organizations to the industry. All of the groups shown in Table 61 have a consensus on the issue.

Table 61
Question 7b Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	1.00	3.00	1.73	2.00	.65	1.00	2.00
Cost Analysts	1.00	3.00	1.73	2.00	.60	1.00	2.00
Contracting Officers	1.00	3.00	1.76	2.00	.54	1.00	2.00
Cost Estimators	1.00	2.00	1.67	2.00	.49	1.00	2.00
Engineers	1.00	3.00	2.00	2.00	.74	1.25	2.75
DCAA	1.00	4.00	1.71	2.00	.64	1.00	2.00
DCMC	1.00	3.00	1.86	2.00	.64	1.00	2.00
Industry	1.00	4.00	1.70	2.00	.82	1.00	2.00

Source: Developed by researcher.

3. Data and Rationale

Additional information that is critical to understanding a parametric cost based estimate is knowing how it has been validated for use. Statement 7c is presented below followed by the analysis of the data collected regarding this issue.

> A potential contractor should provide data and rationale used to validate a parametric cost estimating model for a specific set of circumstances in support of a cost proposal.

The statement indicates the offeror should provide information about how the model was modified, the database updated, and how often these tasks were performed to give the buyers the level of understanding that they need. The groups shown in Table 62 again show the level of agreement with this statement across the DoD acquisition infrastructure.

Table 62
Question 7c Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Staff	2.00	2.00	2.00	2.00	.00	2.00	2.00
Control Group	1.00	3.00	1.73	2.00	.65	1.00	2.00
Cost Analysts	1.00	3.00	1.66	2.00	.52	1.00	2.00
Contracting Officers	1.00	3.00	1.68	2.00	.52	1.00	2.00
Cost Estimators	1.00	2.00	1.67	2.00	.49	1.00	2.00
Engineers	1.00	3.00	1.75	2.00	.62	1.00	2.00
DCAA	1.00	4.00	1.57	2.00	.63	1.00	2.00
DCMC	1.00	3.00	1.79	2.00	.63	2.00	3.00
Industry	1.00	4.00	1.65	2.00	.75	1.00	2.00
NASA	1.00	3.00	1.75	2.00	.54	1.00	2.00
U.S. Navy	1.00	2.00	1.67	2.00	.48	1.00	2.00
USAF	1.00	2.00	1.71	2.00	.47	1.00	2.00

Source: Developed by researcher.

Agreement to this statement was also strong and widely represented in the DoD community. Strongly agree was selected by 71 and agree by 106 respondents leading to an average response value of 1.67, a small standard deviation of .61 and a median value of 2.

Offerors should provide information described in the three statements in question seven. Gathering these data could require new information systems to be used in industry to capture, collate, and display this information. The responses show support from industry to provide this information as well as a desire by those charged with evaluating proposals to have these data available.

C. DCAA SUPPORT

After a proposal is submitted, it is then analyzed in accordance with the evaluation plan. In a four part series of statements, question eight addresses possible functions that may need to be performed and who is best suited to do them. These statements address issues raised in the second subsidiary research question.

> What impacts could emphasis on using cost estimates based on parametric estimating techniques have on source selection criteria and on the evaluation of proposals by the DoD?

Each statement assumes that DCAA is the best organization to perform the task identified. The respondents are asked to

fill in another organization if they feel that DCAA is not the appropriate action agency for the function in question. Information about the written responses will be provided with the analysis for each question.

1. Establishing Validity Metrics

Determining the validity of a parametric model to a given set of circumstances is critical to understanding the outputs of that model, their uses, and limitations. Statement 8a, shown below, addresses this concern.

> DCAA should establish metrics to determine a parametric cost estimating model's validity in a given situation.

Defining measurement criteria to gauge the effectiveness of a model in a particular situation refers to the concept of calibration defined in the Parametric Cost Estimating Handbook. If models are modified for use, descriptions of how they were changed to reflect the situation in which they will be used should be provided to proposal evaluators. This statement asks the respondent to determine who should set forth these criteria.

There was a large amount of agreement with this statement indicating that DCAA should perform this function. The average response value of 2.25 results from the large number of participants (121) agreeing with the statement. The program staff, U.S. Army cost analyst, and USAF contracting officer groups represent agreement within the survey

participants. This is contrasted with the disagreement that the control group expressed. The statement group data are shown in Table 63.

Table 63
Question 8a Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Staff	2.00	2.00	2.00	2.00	.00	2.00	2.00
Control Group	2.00	4.00	2.73	3.00	.77	2.00	3.00
U.S. Army Cost Analysts	1.00	3.00	1.93	2.00	.46	2.00	2.00
USAF Contracting Officers	1.00	2.00	1.83	2.00	.41	1.75	2.00

Source: Developed by researcher.

Regression analysis also showed a disagreement in the responses. The business size regression equation

Business Size

$$Y = \underset{(.17)}{.733}(X) - \underset{(2.36)}{7.64} \qquad R^2 = .51$$

indicates that as the business size increases so does the disagreement with the statement. The same analysis performed with the GS/SES level data shows an opposite relationship. The equation and data

GS/SES Level

$$Y = -\underset{(.13)}{.418}(X) + \underset{(1.84)}{8.28} \qquad R^2 = .23$$

show a negative relationship. As the Government rank rises so does the level of agreement with the statement. The division

is clearly along a Government-Industry split in the acquisition community.

There are two areas that may be the source of the disagreement. The respondents may feel that the function does not need to be performed or that DCAA is not the appropriate organization to do the work. Since the functions described appear as a central concept in the Parametric Cost Estimating Handbook and several papers written by members of the control group, the likely source of the disagreement is in the area of who should do the work. Two answers were written in by the control group. Three people recommended that either

1. DCMC should perform this function, (2) or that

2. This work should be left to the contractor's discretion. (1)

These two responses were also prominent in the aggregate of written responses to this statement.

In all of the surveys returned, six groups other than DCAA were identified to perform this function:

1. Buying Organizations (14)

2. Offerors (12)

3. DCMC (15)

4. Cost Analysis Improvement Group (CAIG) (2)

5. A DCMC, DCAA, Buying Organization, and Offeror Team (2)

6. Program Managers (1)

The majority of the added recommendations concentrated on DCMC, the buying organization, or the contractor performing the work. DCAA and the control group recommend leaving this to the contractor's discretion rather than assigning it as a DCAA responsibility. DCMC and the buying organizations, USAF, U.S. Army, and U.S. Navy, would prefer to take on this function rather than task DCAA with it.

Both possible issues of contention in this statement are addressed by Dennedy, Deutsch, and Hertling in their article. They state that this function must be accomplished and recommend that it be done prior to using the models to generate estimates. [Ref 8:p.1] They also directly address the topic of who should perform this verification activity for models generated by the potential offeror.

> The parametric model (or CER model) should be developed at the local level in coordination with the cognizant ACO and DCAA auditors. Ideally, a team made up of ACO pricing, buying office representatives and the contractor's parametric model builders should develop the model jointly in an integrated product team (IPT) process. The joint team should review and validate the database upon which the model is based, the logic and statistical validity of the model itself and how the model will fit into the contractor's estimating system. DCAA, as an independent examiner, will

> provide input on the contractor's controls, database, and updating procedures. [Ref 8: p.1]

In this way, the teaming concept and IPTs are introduced at a very early point in the procurement process. The write-in responses indicating that a team would be beneficial came from both DCAA and DCMC for this segment of question eight. While teaming may be the best solution to the problem of who should validate and how a model should be validated, the buying organizations do not seem to have considered that idea at this point in responding to this statement.

2. Updating Models

A second facet of model validation concerns when the model is modified or database updated and who should make this decision. Survey participants were asked to record their opinions to statement 8b:

> DCAA should establish criteria to determine when a parametric cost estimating model should be updated.

The same basic issues that are evident in the concept of calibration apply to when a model should be calibrated. The participants agreed to this statement in the majority; 126 people either strongly agreed or agreed with the statement. An average response value of 2.20 and median response of 2 was observed. The data shown in Table 64 represent the agreement throughout the acquisition community on this issue. The unanimous agreement in the program staff group and degree of

consensus reached on this issue in the other groups is noteworthy. Industry and Government members of the acquisition community agree that someone should set criteria to determine when models should be updated. A significant portion (20%) of the respondents recommended that someone other than DCAA be tasked with this function.

Table 64
Question 8b Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Staff	2.00	2.00	2.00	2.00	.00	2.00	2.00
Control Group	1.00	3.00	2.00	2.00	.63	2.00	2.00
U.S. Army Cost Analysts	1.00	3.00	2.00	2.00	.52	2.00	2.00
Industry Cost Analysts	1.00	2.00	1.86	2.00	.38	2.00	2.00
Contracting Officers	1.00	3.00	2.00	2.00	.61	2.00	2.00

Source: Developed by researcher.

With the exception of the program managers, the list of other recommendations is the same as in the previous statement. The buyer (9), offeror (5), DCMC (18), and a team arrangement (4) were the groups most often recommended to perform this work. Of the responses from buying organizations, the write-in responses recommended either that

they should determine when a proposed model requires updating or that DCMC take on that work. The DCAA written recommendations indicate that the offeror should perform this work.

The Dennedy et al article does not specifically address the issue of when a model should be updated but the concept is included in the duties listed for the team members. Inherent in the article is an assumption that the offeror has taken the initiative to keep the model current and that it is applicable to the given situation. The Government functions in a review and evaluation mode with three organizations, DCAA, DCMC, and the buying office, performing various review duties. The currency of the model is considered in the:

1. DCAA review of calibration and validation of the tools,

2. DCMC technical review of the contractor's cost modeling technique, and

3. Buying office review of the offeror's assumptions made in the model. [Ref 8:p.3]

Ideally, this would be performed in the team environment presented in the previous statement analysis. However, the written responses to this question indicate that the buying organizations, DCMC and DCAA, do not view teaming as an answer to this problem.

3. Model Validation

The issues addressed in statement 8c, shown below, are centered around the concept of model validation.

> DCAA should verify that a parametric cost estimating model accurately predicts costs for the expected contract work.

While there is no way to be completely certain, until after the work is done, that a model has accurately predicted the costs for a project, there are methods that can be used to determine its accuracy. This process is described in detail as validation in the Parametric Cost Estimating Handbook. It may include:

> 1. Calibration of the model to historical cost data,
>
> 2. Estimating the cost of past completed projects, and
>
> 3. Comparing these estimates with actual costs to demonstrate acceptable accuracies, [Ref 37:p.18]

as steps in a validation process. The average response value of 1.93 and median value of 2 show a strong level of agreement with the survey statement. The strong support for the statement is shown throughout the survey respondents in the group data presented in Table 65. Program personnel, contracting officers, and industry groups all agreed that DCAA should perform this verification. That a smaller number of written recommendations was received for this statement

indicates agreement that DCAA is also the organization best suited for doing this work.

Table 65
Question 8c Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Staff	2.00	2.00	2.00	2.00	.00	2.00	2.00
U.S. Army Cost Analysts	1.00	4.00	1.94	2.00	.68	2.00	2.00
Industry Cost Analysts	1.00	3.00	1.86	2.00	.69	1.00	1.00
Contracting Officers	1.00	3.00	1.83	2.00	.59	1.00	2.00
Program Managers	1.00	2.00	1.83	2.00	.41	1.75	2.00
Corporate Policy	1.00	2.00	1.75	2.00	.50	1.25	2.00
Prepare For Negotiations	1.00	4.00	1.83	2.00	.67	1.00	2.00

Source: Developed by researcher.

Dennedy, Deutsch, and Hertling also state clearly the function should be performed by DCAA but they emphasize that ideally it would be done in a team environment. [Ref 8:p.3] The results of the recommendations received show that, again, buyers would prefer to retain this work or task DCMC with it. DCMC written recommendations are that they would prefer to retain it. It should be noted that only 15% of the respondents chose to provide a written response. Of the total

number of written recommendations to this statement, DCMC provided six. DCAA is well-suited to perform this task in their traditional role, and the lack of DCAA written responses shows an agreement to take on this work.

4. Model Operation

The basis of analyzing a cost proposal is understanding the proposal in detail and the relationships within it. Using an offeror's model to generate cost estimates is one method of applying the information provided about that model to ensure this level of understanding. The final statement of question eight asks the respondents to give their opinion about the issues in this statement:

> DCAA should run a contractor's parametric cost estimating model for purposes of analyzing the cost proposal.

There was again a great deal of agreement with DCAA being tasked with operating an offeror's model for these purposes. There were 129 responses in agreement with this statement which produced an average response value of 2.08 with a .74 standard deviation and a median value of 2. Table 66 presents the group data for this statement. Notably, the control, program manager, and program staff groups were unanimous in their agreement with the idea that DCAA should provide this service. One major buying organization, contracting officers and three job description groups reached a consensus that this service should be provided.

Table 66
Question 8d Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Control Group	2.00	2.00	2.00	2.00	.00	2.00	2.00
Program Staff	2.00	2.00	2.00	2.00	.00	2.00	2.00
U.S. Army Cost Analysts	1.00	3.00	2.00	2.00	.56	2.00	2.00
Contracting Officers	1.00	3.00	1.95	2.00	.52	2.00	2.00
Program Managers	2.00	2.00	2.00	2.00	.00	2.00	2.00
U.S. Army	1.00	4.00	2.03	2.00	.58	2.00	2.00
Prepare For Negotiations	1.00	4.00	1.93	2.00	.63	2.00	2.00
Prepare Estimates	1.00	4.00	2.11	2.00	.64	1.00	2.00

Source: Developed by researcher.

Written responses to this statement show that buyers and DCMC would prefer to perform this work themselves. The lack of DCAA written responses would indicate that they agree with their organization being tasked with this function. Regression analysis performed on the experience data presents the following relationship:

$$Y = \underset{(.07)}{-.192}(X) + \underset{(2.06)}{7.48} \qquad R^2 = .04$$

The weak negative relationship indicates that as experience increases so does the agreement with this statement. Stronger

support for this statement is coming from more experienced groups such as the prepare estimates work classification group. Notably there was a lack of consensus in the industry and corporate policy groups on the issue of DCAA operating a parametric cost estimating model for analysis purposes.

The Dennedy article provides a description of a possible mechanism for accomplishing an agency running an offeror's model. The article espouses having the offeror make the model available to the Government rather than providing a copy of the model to the Government as discussed in question 7a. The agency responsible for operating the model in the contractor facility is not addressed, however. The chief advantage to this solution is the model remains a part of the estimating system that generated the offer in the proposal rather than a separate piece to be inserted into a negotiating position.

5. Summary

Agreement was observed for all four of the question eight statements. Minor areas of disagreement seem to be related to who would perform the work or function described rather than if the work should be performed at all. At most, 25% of the respondents chose to offer a recommendation for some organization other than DCAA to be tasked with the work described in any one of the statements. Additionally, less than 25% of the respondents disagreed with any one of the

statements in question eight. Written responses to these statements indicate a preference for two groups, DCMC and the buying organizations, taking on this function if DCAA does not do it. This desire to be involved in these aspects of the model evaluation could be beneficial. The team environment described by Dennedy, Deutsch and Hertling is a viable vehicle for combining the experience, knowledge, and needs of these groups to provide a single face to industry in another area of the acquisition process to address common goals.

D. TECHNICAL PROPOSAL EVALUATION IMPACTS

Participants to question nine, shown below, were asked to record their opinions about the information that parametric methods could provide in technical proposal evaluation.

> Construction of cost estimating relationships used in parametric cost estimate based proposals should be used as a factor in evaluating a contractor's level of understanding of the technical requirements in a solicitation.

Subsidiary question two and three issues are addressed in this statement. Source selection criteria and evaluation factors should take the entire proposal into account. Technical understanding and capability can be revealed in the way the offeror intends to manage the effort, the way the relationships in the cost estimate are related as well as in the verbiage in the technical proposal itself.

The average response value of 2.37 and median value of 2 indicate a fair amount of agreement with this statement. Table 67 shows that the program manager and NASA groups were strongest in their agreement with the statement. Buying organizations, U.S. Navy, support groups in the acquisition community, and contracting officers, particularly USAF contracting officers, also agreed with this premise.

Table 67
Question 9 Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Contracting Officer	1.00	4.00	2.18	2.00	.68	2.00	2.00
USAF Contracting Officers	2.00	2.00	2.00	2.00	.00	2.00	2.00
Cost Estimators	2.00	4.00	2.28	2.00	.49	2.00	2.25
NASA	1.00	2.00	1.86	2.00	.38	2.00	2.00
U.S. Navy	1.00	3.00	2.00	2.00	.56	2.00	2.00
Program Managers	1.00	2.00	1.67	2.00	.52	1.00	2.00
Auditors	1.00	4.00	2.13	2.00	.73	2.00	3.00
Technical Support	2.00	4.00	3.67	4.00	1.5	2.00	4.00

Source: Developed by researcher.

Analysis of variance of job description groups revealed that program managers, contracting officers, and auditors, 69 respondents, agreed that CER construction should be considered as a technical evaluation factor. It also showed that the

technical support participants strongly disagreed with this statement although they do represent a very small group within the pool of respondents. This is an interesting response from those who would be likely to be assigned technical proposal evaluation duties. Table 68 contain the job classification analysis of variance data.

Table 68
Analysis of Variance For Question 9 Data

Job Description	DF	Σd^2	σ^2	F	P
Between Groups	9	14.51	1.61	2.51	.01
Within Groups	134	86.03	.64		

Source: Developed by researcher.

Weak negative relationships between responses and both GS/SES level and experience were also noted. The equations

GS/SES Level

$$Y = -.336(X) + 7.29 \qquad R^2 = .13$$
$$\quad (.15) \qquad (2.07)$$

Experience

$$Y = -.179(X) + 7.45 \qquad R^2 = .02$$
$$\quad (.09) \qquad (2.44)$$

indicate that as GS/SES level or experience increases the agreement with the statement also increases slightly. This also supports the agreement levels seen in the auditor, cost estimating, and NASA groups. These groups are among the more experienced groups of all the demographic categories in the respondent pool.

The agreement with question nine indicates that consideration should be given to this aspect of technical proposal evaluation. With the strong disagreement from the technical support community, it may be prudent to involve someone from this community early in the process of developing an evaluation plan to encourage a team effort. Consideration should also be given during construction of the plan to allowing flexibility in the event both parametric-based and traditional cost proposals are submitted. As discussed in question 6g, fairness is essential in any source selection plan.

E. NEGOTIATIONS

Question ten is a four part series of statements dealing with the effects that parametric cost estimating may have on the negotiation process. This process can be a factor in both pre-award as well as post-award circumstances as noted in question four. Issues in the fourth subsidiary research question are addressed in this series of statements.

1. Cost or Price Negotiation Criticality

The first area of interest in statement 10a, shown below, is the effect estimate accuracy might play in negotiations.

> Using parametric cost estimating methods should make negotiating costs less critical as cost estimate accuracy improves.

As estimates become more precise, will the issue of cost become less of an issue? The question assumes that cost will always remain an evaluation factor in any proposal evaluation. There was a lack of agreement and consensus among the participants on this issue. An average response value indicates disagreement but the median value of 2 indicates agreement with the statement. The program staff and industry cost analyst data displayed in Table 69 are the only demographic categories that exhibit any consensus on this issue. The program staff group is unanimous in their disagreement that costs will become less important as estimate accuracy improves. The industry cost analysts see a shift in emphasis from costs to other factors as estimates become more precise.

Table 69
Question 10a Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Program Staff	3.00	3.00	3.00	3.00	.00	3.00	3.00
Industry Cost Analysts	2.00	3.00	2.14	2.00	.38	2.00	2.00

Source: Developed by researcher.

FAR 15.406-4 notes that cost will be included as a factor in source selection. This statement raises the question of how much will cost be a factor, if because of increasing accuracy, the acceptable range of both parties in a

negotiation is very narrow and overlapping. Parametric estimates derived from the same models and estimating systems for both offeror and buyer have the potential for this situation if the offeror's facilities are used as discussed in the statement 8d analysis. In the event that this occurs, the negotiations may shift from cost concerns to ones of a technical ability or schedule nature. Another possibility that is more likely is a shift in negotiations to inputs to the model and the assumptions that go with them if the model and estimating system are accepted as validated by both parties in a negotiation situation.

2. Cost as an Independent Variable Impacts

Statement 10b attempts to relate Cost As An Independent Variable (CAIV) with parametric cost estimating during the negotiation process. The second statement of question ten is shown as:

> Using parametric cost estimating methods should have little effect on negotiations as the concept of cost as an independent variable shifts emphasis to technical and schedule concerns for a given value.

The concept of CAIV shifts emphasis to technical or other issues by making costs more of a constraint than an outcome of a series of events in a program. Prior to CAIV, there was an emphasis on cost control but it was still managed as a dependent variable in the program life cycle. CAIV introduced

the idea that costs would actually be controlled to some degree by working within some trade space with technical capability, logistics supportability, schedule, and other concerns to produce and field affordable weapons systems in a timely manner.

There was a large degree of disagreement with this statement. The majority of respondents to this question (104) either disagreed or strongly disagreed with this statement. The disagreement was somewhat of a consensus with an average value of 2.83, a standard deviation of .70 and a median value of 3. Disagreement with this statement was widespread throughout the DoD acquisition community as shown by the group data in Table 70. Four of the largest groups of participants, contracting officers, DCAA, DCMC, and the U.S. Army had a consensus in their disagreement with this issue.

Table 70
Question 10b Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Contracting Officers	2.00	4.00	2.91	3.00	.61	3.00	3.00
U.S. Army	2.00	4.00	2.93	3.00	.66	2.25	3.00
DCAA	2.00	4.00	2.92	3.00	.66	2.00	3.00
DCMC	2.00	4.00	2.82	3.00	.66	2.00	3.00

Source: Developed by researcher.

The depth of feeling over this indicates that CAIV will have little effect during negotiations in shifting emphasis to other issues.

3. Minor Impacts on Source Selection

While cost realism may be a major part of a source selection plan, it should be limited in its impact on other areas of an evaluation. All of the proposal component parts are interrelated to some degree but the factors should have some degree of independence. This statement explores the effects of parametric cost estimating methods and cost realism in source selection.

> Using parametric cost estimating methods should have little effect on source selection, they only affect cost realism.

The aggregate data for this statement shows disagreement with an average response value of 2.66, a standard deviation of .78, and a median value of 3. Table 71 contains data from a major buying organization, USAF, and two vital components of the DoD acquisition community, the auditor and cost estimator groups, that disagree with this statement.

This is contrasted with the regression analysis performed with the business size data. The equation and data

$$Y = \underset{(.17)}{-.360}(X) + \underset{(2.30)}{7.38} \qquad R^2 = .18$$

display a negative relationship between business size and the response value for this statement. As the business size increases so does the level of agreement with this statement. The industry and corporate policy groups do not show any consensus in their opinion on this statement, however.

Table 71
Question 10c Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Auditors	1.00	4.00	2.56	2.50	.70	2.00	3.00
Cost Analysts	2.00	4.00	2.87	3.00	.66	2.00	3.00
USAF	2.00	4.00	3.06	3.00	.68	3.00	3.75

Source: Developed by researcher.

4. Significant Impacts on Source Selection

The interrelated nature of the parts of an offeror's proposal could make the effects of one element have a disproportionate effect in the source selection process. There was a similar lack of consensus on statement 10d (shown below) as there was in statement 10c.

> Using parametric cost estimating methods should have a major effect on source selection, they affect past performance, technical, management, and cost factors in proposal evaluation schemes.

An average response value of 2.48 and a median value of 2 was observed. The distribution of responses was strongly agree,

20, agree, 67, disagree, 68, and strongly disagree 16. Relatively few people (39) chose no opinion or did not respond to this statement. The DCAA and corporate policy group responses in Table 72 are indicative of the range of opinion to this statement. They are not, however, indicative of the degree of consensus on this issue. These two groups were the only ones to show any sort of consensus of the demographic groups analyzed. The contrasting opinions between industry and DCAA in the acquisition community is clear. The industry business size regression analysis results

$$Y = +.385(X) - 2.77 \qquad R^2 = .22$$
$$(.16) \qquad (2.21)$$

show a positive relationship between the responses and the size of the business. The smaller businesses strongly agree with the statement while the larger ones merely agree.

Table 72
Question 10d Group Data

	Min	Max	μ	Median	σ	Q1	Q3
Corporate Policy	1.00	2.00	1.75	2.00	.50	1.25	2.00
DCAA	2.00	4.00	2.81	3.00	.69	2.00	3.00

Source: Developed by researcher.

The industry responses to this statement and question 10c are consistent. The regression analysis demonstrates opposite trends for these two contrasting statements, and from this one could interpret that the industry portion of the DoD

acquisition community views a proposal as a highly integrated whole rather than separate sections. The Government, however, may not see the issue in the same way. DCAA responding to this statement and the technical support group in responding to question nine disagree with the idea that using parametric cost estimating methods can have significant effects on the source selection and subsequent negotiation processes.

Dennedy, Deutsch, and Hertling also disagree with the premise that the use of parametric cost estimating methods can have an effect on negotiations. [Ref 8:p.3] The negotiation process is based on estimates of all types and parametric estimates are only one of many sources of information. In total, the results of statements 10a through 10d indicate that the DoD acquisition community does not believe that the use of parametric cost estimating methods will change the fundamental nature of negotiations. It will simply redefine some of the points around which the negotiations may flow.

F. SUMMARY

This chapter and the preceding two chapters described the data collection efforts and analyses conducted for this thesis. Data collection was chiefly done through a ten question survey distributed to members of the DoD acquisition community. Personal interview information was also collected and presented with each question's survey information as it

pertained those questions or statements. The combined data were examined for indications regarding the overall opinion of the entire DoD acquisition community about each issue. The demographic group data were then examined and contrasted with the entire group responses and between group responses. Any groups within the database that had any opinion that was markedly different from that of the entire respondent pool were highlighted. An analysis of this information was presented for each segment of each question. The final chapter in this thesis will conclude the study with conclusions and recommendations made from the analysis.

IX. PRINCIPAL FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

A. PURPOSE

The primary purpose of this study was to examine the effects of increasing the use of parametric cost estimation methods in individual contract actions. This chapter will provide conclusions about those effects and recommendations for expanding the part that parametric cost estimating methods play in Federal Government acquisition processes. Principal findings and conclusions will be addressed and then they will be followed by the recommendations. Areas of further research will be the final section of this thesis.

B. CONCLUSIONS

The DoD acquisition community views the use of parametric cost estimating as having limited applicability. Areas that can be termed traditional uses have the highest degree of utility in questions one through four. The acquisition community believes that the methods are best applied to developmental applications and serve little purpose outside those areas. The data support the conclusion that the DoD acquisition community is not familiar with the techniques and methods used in parametric cost estimating. They do not have an appreciation of the benefits that parametric cost

estimating can provide across the entire spectrum of activity in the DoD acquisition process.

Practical experience with using the methods in the acquisition process and research on the possible applications for the methods provide a different view. NASA, industry, and the control group responses clearly showed that the methods can be used successfully in a far wider range of activities than they are normally applied by DoD agencies. They also demonstrated areas that have clearly not benefitted by the use of parametric cost estimating methods, such as contracting for commodities, T&M/Labor hour contract situations, and in most areas of the PF/D&OS phase. Parametric cost estimating also may be applied in those areas, however, currently they are not being used there. The methods may not provide enough improvement over existing estimating systems to make investments in them cost effective.

The potential effects of using parametric cost estimating methods will require some changes to be made to the way data are collected, reviewed, presented, and analyzed. However, they will not fundamentally change the acquisition process. The DoD acquisition community views parametric cost estimating methods as an incremental step in increasing the efficiency of the acquisition process. The community acknowledges the fact that the methods can affect almost every action in the DoD

procurement process. They also note that if the methods are to be used, they must be considered from the initial planning stages.

The members of the acquisition community also are viewing the use of parametric cost estimating methods in terms of acquisition reform. The data demonstrate a preference for giving the contractor community latitude to use the methods as they fit best in the contractor's systems rather than as requirements to be met. The data also indicate that the acquisition community would accept the idea that teaming concepts have potential benefits to parametric cost estimating. Major stakeholders in the community identified each other as important members of the process whereby a parametric cost estimating model is calibrated and validated for use. The use of teaming and parametric cost estimating fit in well with the concept of disengagement by DoD in its contractor estimation system review programs.

C. RECOMMENDATIONS

The primary recommendation of this thesis is to maintain the Parametric Cost Estimating Initiative and the Joint Industry/Government Working Group. This initiative, through the working group, has been instrumental in bringing awareness to the benefits that parametric cost estimating can provide. The workshops which the working group sponsors and newsletters

that it publishes are outstanding fora for publicizing these benefits, exploring new areas in which the methods can be applied, and producing meaningful discussion about actual application of the methods in specific situations. The large number of surveys not answered indicates that the majority of the DoD acquisition community is still unfamiliar with parametric cost estimating methods.

A second recommendation is to evaluate and publish results from the Joint Government/Industry Parametric Cost Estimating Pilot Program. The lessons learned and successes will help to promote the use of the methods and also to publicize how they can benefit both Government and Industry. Business case analyses could be performed with these results to quantify the effects of using parametric cost estimating methods and implementation procedures.

Training the acquisition community is the third recommendation of this thesis. One of the major efforts of the working group has been to establish a training program in the area of parametric cost estimating. The training should be made readily available to the acquisition community as rapidly as possible to reap the maximum benefits from the use of the methods. Training should also include a review of the existing curricula for acquisition workforce professionals. A brief discussion regarding parametric cost estimating

methods to introduce them to the workforce could provide basic awareness and understanding of the methods if it were added to existing cost and pricing course materials.

Parametric cost estimating methods should be considered for incorporation in DoD modeling and simulation programs for acquisition purposes. The U.S. Navy Acquisition Center for Excellence (ACE) could potentially benefit from the use of the methods as well as provide awareness to the acquisition community about their potential applications. The U.S. Navy Research Development and Acquisition Team Strategic Plan for 1996 and 1997 provides several other areas where the methods could be applied. The strategic goals for total ownership cost and innovation/technology insertion discuss modeling and simulation areas that could also benefit from using parametric cost estimating methods.

Connectivity between databases should be improved. As more of the DoD systems and equipments incorporate COTS and NDI, integration will become a major cost driver. Parametric estimating could be helpful in modeling the integration schedule and costs if databases for the individual equipments could be integrated. Parametric estimation of total life cycle costs could also benefit from greater connectivity between databases.

D. FURTHER RESEARCH TOPICS

The following is a list of several areas that might be of interest and benefit to the acquisition community regarding parametric cost estimating:

1. Business case analyses of the Government agencies and companies involved in the Joint Government/Industry Parametric Cost Estimating Pilot Program could provide greater insights to the application of parametric cost estimating methods to DoD acquisition.
2. A review of how the use of parametric cost estimating methods affect the DoD estimating system review program would be useful to buying organizations as well as DoD administrative agencies.
3. Business case analyses of parametric estimating applications to the concept of total life cycle costs would provide benefits to future programs and DoD managers.
4. A review of the regulatory and other barriers to effective implementation of using parametric costing could benefit those interested in promoting the wider use of the methods.

E. FINAL SUMMARY

The final summary of the issues addressed in this thesis will be a restatement of the research questions followed by brief answers.

Primary Research Question:

How could a DoD emphasis on using parametric methods in cost estimating affect the procurement process?

Answer: A DoD emphasis on parametric methods in cost estimating could influence almost every step in the acquisition process in some way. The effects that they would cause would be minor in nature, however.

Subsidiary Research Questions:

1. What changes could offerors make to their proposal preparation, submission, and support processes to accommodate using parametric methods, techniques, or software in estimating potential contract costs?

Answer: Offerors desiring to incorporate parametric cost estimating methods into their proposal preparation processes could either use a commercially available model or develop one of their own. In either case a database from which to work is essential and must be constructed. The decisions made here will influence the ability of the offeror to respond successfully to Federal Government solicitations.

2. What impacts could emphasis on using cost estimates based on parametric estimating techniques have on source selection criteria and on the evaluation of proposals by DOD?

Answer: Cost estimates based on parametric estimates could impact the entire source selection process. They have impacts on the evaluation plan, the proposals

submitted, and thus the material available for evaluation and source selection decisions.

3. How could source selection criteria and evaluation factors be constructed to fairly evaluate a proposal that uses a parametric cost estimate with one that does not?

Answer: Source selection criteria must be flexible enough to include proposals based on parametric estimates as well as ones based on traditional estimates. Failing to do so could impact the level of competition in a given procurement.

4. What effects could using parametric cost estimations have on negotiations?

Answer: Parametric cost estimating methods should have little effect on negotiations. The points around which one negotiates may shift to inputs to the model rather than specific cost elements but the basics of negotiation will remain the same. Cost will always be a factor.

APPENDIX A. DEFINITIONS

Analogy Model - a model that estimates costs of a new program or system from data on past costs of similar programs or systems. [Ref 23:p.290]

Analysis of Variance - an expression of the measure of total variation in a data set as a sum of terms, which can be attributed to specific sources, or causes of variation. [Ref 37:p.207]

Benchmarking Process Costs - generating an estimate of the costs associated with a process for later comparison with other estimates or actual costs.

Bottoms Up Cost Estimate (Detailed Cost Estimate) - an estimate of project component costs from detailed understanding of the cost elements of each component. Supplier quotations, labor hour estimates from time and motion studies or labor hour and material estimates from learning curve analyses form the basis of these estimates. [Ref 2:p.294]

Calibration - the process of indexing a parametric model or system to local cost and product history. [Ref 5:p.4]

Capacity Cost Estimates - estimates based on logarithmic plots of similar plants which show a relationship between capacity and costs. [Ref 14:p.132]

Coefficient of Determination - the proportion of variation in the dependent variable that has been explained or accounted for by the regression line. [Ref 37:p.46]

Commercial-Off-The-Shelf - an existing system or equipment that is sold to the Federal Government in the same configuration that it is sold to the general public or with minor modifications. [Ref 3:p.42]

Cost Analysis - the review and evaluation of a contractor's costs or pricing data, and of the judgmental factors applied in projecting from the data to the estimated costs, for the purpose of determining the degree to which the contractor's proposed costs represent what contract performance should cost, assuming reasonable economy and efficiency. [Ref 3:p 19]

Cost or Pricing Data - all facts that ... prudent buyers and sellers would reasonably expect to affect price negotiations significantly. [Ref 13:part 15.801]

Cost Realism - means the costs in an offeror's proposal are realistic for the work to be performed, reflect a clear understanding of the requirements and are consistent with the various elements of the offeror's technical proposed. [Ref 13:part 15.801]

Dependent Variable - the variable whose value is to be predicted. [Ref 37:p.39]

Equipment-Ratio Estimates - estimates derived from process flow diagrams and equipment lists with installation and construction costs estimated as a ratio of past similar efforts. [Ref 14:p.132]

Expert Opinion - the use of the judgment of experts when supporting data or program definitions are insufficient. [Ref 23:p.290]

Independent Variable - the variable about which knowledge can be obtained. [Ref 37:p.39]

Layout Estimates - estimates from plant layouts and process flows and equipment lists. [Ref 14:p.132]

Learning Curve - an empirical relationship between the number of units of an item produced and the number of units of a resource used to produce them. The most common relationship used is units of production and number of labor hours required to produce the units. [Ref 1:p.267]

Negotiation - a process between buyers and sellers seeking to reach mutual agreement on a matter of common concern through fact finding, bargaining, and persuasion. [Ref 3:p.41]

Non-developmental Item - an item developed exclusively at private expense and sold in substantial quantities, on a competitive basis, to multiple state and local governments. [Ref 13:part 2.101]

Parametric Cost Estimate - an estimate derived from statistical correlation of historic system costs with performance and/or physical attributes of the system. [Ref 37:p.172]

Performance Specification - a description of a deliverable in terms of desired operational capabilities. [Ref 3:p.44]

Preliminary Bill Estimates - estimates derived from bills of material produced from initial drawings and labor-material ratios from past work. [Ref 14:p.132]

Price Analysis - the process of examining and evaluating a proposed price without evaluating its separate cost elements and proposed profit. [Ref 13:part 15.8]

Regression Analysis - the mathematical nature of the association between two variables. [Ref 37:p.39]

Risk - the probability of not attaining the goals for which the party entered a contract. [Ref 3:p.51]

Source Selection - the process wherein the requirements, facts, recommendations and policies relevant to an award decision in a competitive procurement of a system/project are examined and the decision is made. [Ref 3:p.53]

Standard Error of the Estimate - the standard deviation of the population of y values predicted from a single value of x. [Ref 23:p.305]

Top Down Cost Estimate - an overall cost estimate for a proposed project based on the global properties of the project from which component parts are partitioned for planning purposes. [Ref 34:p.176]

Validation - the process or act of demonstrating the calibrated model's ability to function as a credible forward estimating tool or system. [Ref 5:p.4]

Work Breakdown Structure - a product-oriented family tree resulting from system engineering efforts which completely define the program. [Ref 37:p.176]

APPENDIX B. LIST OF ACRONYMS

Σd^2 - Sum of the Squares

σ^2 - Population Variance

ACE - Acquisition Center of Excellence

ACO - Administrative Contracting Officer

ACT - Active Coefficient

CAIG - Cost Analysis Improvement Group

CAIV - Cost As An Independent Variable

CAS - Cost Accounting Standards

CE - Concept Exploration

CER - Cost Estimating Relationship

CICA - Competition in Contracting Act

COCOMO - Constructive Cost Model

COTS - Commercial off the Shelf

CPAF - Cost-Plus-Award-Fee Contract

CPFF - Cost-Plus-Fixed-Fee Contract

CPIF - Cost-Plus-Incentive-Fee Contract

CPRG - Contract Pricing Reference Guides

DCAA - Defense Contract Audit Agency

DCMC - Defense Contract Management Command

DEVC - Development Cost Variable

DF - Degrees of Freedom

DFARS - Defense Federal Acquisition Regulation Supplement

DLSIE - Defense Logistics Studies Information Exchange

DoD - Department of Defense

DoE - Department of Energy

DoN - Department of Navy

DTIC - Defense Technical Information Center

ECP - Engineering Change Proposal

E&MD - Engineering and Manufacturing Development

F - F Statistic

FAR - Federal Acquisition Regulation

FFP - Firm Fixed-Price Contract

FPE - Fixed-Price with Economic Price Adjustment Contract

FPIF - Fixed-Price Incentive Firm Contract

FPIS - Fixed-Price Incentive, Successive Targets Contract

FPRA - Forward Pricing Rate Agreement

FPR(P) - Fixed-Price with Prospective Redetermination Contract

FPR(R) - Fixed-Ceiling-Price with Retroactive Redetermination Contract

ICE - Independent Cost Estimate

GS - General Service

GSA - General Services Administration

IPCE - Independent Parametric Cost Estimate

LG - Large Ship Factor

LRIP - Low Rate Initial Production

LSBF - Least Squares Best Fit

NASA - National Aeronautics and Space Administration

NDI - Non-developmental Item

OSD - Office of the Secretary of Defense

P - P value

PCO - Procuring Contracting Officer

PD&RR - Program Definition and Risk Reduction

PF/DOS - Production, Fielding/Deployment and Operational Support

PRICE - Programmed Review of Information for Costing and Evaluation

PROC - Procurement Cost Variable

R^2 - Coefficient of Determination

RDT&E - Research, Development, Test, and Evaluation

SES - Senior Executive Service

SM - Small Ship Factor

SOW - Statement of Work

SPI - Single Process Initiative

SSE - Standard Sum of the Errors

T&M - Time and Materials Contract

TINA - Truth in Negotiations Act

USAF - United States Air Force

USA - United States Army

USN - United States Navy

WBS - Work Breakdown Structure

APPENDIX C. SURVEY QUESTIONS

Please use the following as a definition, taken from the DoD Parametric Cost Estimating Handbook published in the fall of 1995, for Parametric Cost Estimating (PCE):

"A technique employing one or more Cost Estimating Relationships (CERs) and associated mathematical relationships and logic. The technique is used to measure and/or estimate the cost associated with the development, manufacture, or modification of a specified end item. The measurement is based on the technical, physical, or other end item characteristics."

PARAMETRIC COST ESTIMATING SURVEY

Please complete the following demographic information.

1. What is your job classification? (Select 1 that fits best or write in a specific title if none apply.)

____ Cost Estimator _____ Cost/Price Analyst ____ Contract Negotiator
___ Contracting Officer ____ Program Staff _____ Program Manager _____ Engineer
_____ Legal Support ____ Technical Support _____ Auditing _____ Accounting
Other ____

2. If employed by industry, annually does your company do business with the Federal Government totaling:

< $100 Million _____ $100 - 500 Million ______ $ 500 - $ 1 Billion _____ > $1 Billion _____

3. If employed by the Federal Government:

____USA ____ DCMC ____ DCAA ____NASA ___USN ____ USAF ____ GSA
Other:__________________________ _____ GS/SES Level/Rank

4. How long have you been working in the _____cost estimating ____ or acquisition fields? (Please select either career field and the appropriate length of time.)

___One year or less ____1-5 years ____ 5-10 years ____10-20 years ___Over 20 years

5. What functions involving cost estimating do you primarily perform?

____Prepare Estimates _____Use in Negotiation Preparation or Proposal Analysis
____Review/Audit Estimates Set ____Corporate or ____Federal Government Policy

6. What is your level of mathematics knowledge?

___ High School Algebra/Calculus ____ College Algebra ____ College Business Calculus
___ College Engineering Calculus Series ____ College Mathematics Minor/Major
___ Advanced Degree Involving Training in Mathematics Other ____________________

Please record your opinions regarding the following questions relating to PCE.

For questions 1 through 4, use the following scale to represent the utility of PCE in the listed areas.

(1) Vital (2) Very Useful (3) Somewhat Useful (4) No Use (5) Hinders the Process

1. How useful is PCE in these areas?

______Bench Marking Process Costs ________Validating Bottom's Up Estimates
______Program Estimates ____Budgeting _____ ICE Generation ____Software Contracts
______Repair Parts Contracts ____R&D Contracts _____Service Contracts
_____Hardware Contracts ____Construction Contracts _____Commodity Contracts

PCE is also useful for: (Please fill in other areas.)

2. How useful is PCE in each of the stages of a system's life cycle?

Concept Exploration	Program Definition & Risk Reduction	Engineering & Manufacturing Development	Production, Fielding/ Deployment & Operational Support
_____	______	_____	_____

3. How useful is PCE in situations where you would also use the following contract type:

FFP	FPE	FPIS	FPR(P)	FPR(R)	FPIF	CPIF	CPAF	CPFF	T&M	Labor Hour
____	____	____	_____	____	____	____	____	____	____	____

PCE is also useful for this contract type situation _______________ . (Please fill in others.)

4. How useful is PCE in estimating costs for activities in these two areas of contract management?

______ Pre-Award Actions _______ Contract Post-Award Actions

This part is a series of statements about the use of PCE methods. Using the following scale, please indicate to the left of each statement, the degree to which you agree or disagree with them.

(1) Strongly Agree (2) Agree (3) Disagree (4) Strongly Disagree (5) No Opinion

5. PCE methods, models and software:

a.______ Could eventually replace traditional "bottoms up" cost estimating methods in many acquisition estimating applications as a result of acquisition streamlining.
b._____ Could replace traditional cost estimating methods as larger, more compatible data bases, greater computing power and improved software become available.
c._____ Can save contractors and Federal Government oversight officials significant time and expense in developing and then evaluating proposals.
d.______ Could significantly change the way potential contractors collect and summarize cost information.
e._____ Should decrease the probability of cost overruns in programs where used.
f._____ Should change the way Cost and Pricing Data submitted to support a proposal is viewed.

6. In solicitations, buying activities should:

a._____ Encourage that PCE be used for specified procurement actions.
b.____ Specify PCE methods, models, or software for cost proposal construction.
c._____ Leave PCE methods, models, or software selection to contractor discretion.
d._____ Require a specific cost breakdown format for PCE based cost proposals.

e._____ Require a specific format to extract labor hour, subcontractor, or material quantity estimates for technical proposal evaluation.

f.____ State criteria to be used to evaluate the statistical significance of CERs used to support a PCE model.

g.____ Require cost proposals based on either PCE methods or traditional costing methods. Evaluation schemes cannot fairly distinguish between proposals using different costing methods for the same work.

7. A potential contractor should provide the following to support a cost proposal:

a.____ PCE model software and input data used.

b.____ Justification to support the use of PCE models and input data.

c.____ Data and rationale used to validate a PCE model for a specific set of circumstances.

8. DCAA should perform the following activities: (If not DCAA, who should do them?)

a.____ Establish metrics to determine a PCE model's validity in a given situation. ______

b.____ Establish criteria to determine when a PCE model should be updated. _________

c.____ Verify that a PCE model accurately predicts costs for the expected contract work.

d.____ "Run" a contractor's PCE model for purposes of analyzing the cost proposal. ___

9.______ Construction of CERs used in PCE based proposals should be used as a factor in evaluating a potential contractor's level of understanding of the technical requirements in a solicitation.

10. Using PCE methods:

a._____ Should make negotiating costs less critical as cost estimate accuracy improves.

b.______ Should have little effect on negotiations as the concept of Cost as an Independent Variable shifts emphasis to technical and schedule concerns for a given value.

c.____ Should have little affect on source selection, they only affect a proposal's cost realism.

d.____ Should have a major affect on source selection, they affect past performance, technical, management, and cost factors in proposal evaluation schemes.

APPENDIX D. INTERVIEW QUESTIONNAIRE

1. How should an emphasis on using parametric methods in cost estimating affect the procurement process?

2. How could the use of parametric cost estimates be incorporated into program management beyond their traditional uses?

3. How far should DoD/DoN go in emphasizing parametric cost estimating methods?

4. Should the use of parametric cost estimates be required for certain procurement actions?

5. What information should DoD/DoN agencies expect potential contractors to provide in support of their proposals that use parametric cost estimating techniques for proposal preparation?

6. Do you see any major changes to the way solicitations are structured, proposals are generated, proposals evaluated, and sources selected because of an emphasis on using parametric cost estimating techniques?

7. What support should DoD/DoN organizations expect of DCAA and DCMC for analyzing parametric cost estimate based proposals?

8. Should DoD/DoN provide guidance on how the variance between a parametric cost estimating model and the work described on a solicitation be measured?

APPENDIX E. COLLECTED DATA

DEMOGRAPHIC GROUP INFORMATION

Group Name	Sort Code	# of Responses/ %of Responses	Math Sort Code μ	Math Sort Code σ	Experience Sort Code μ	Experience Sort Code σ
Control Group		11 5.3%				
Job Classification						
Cost Estimator	1	14 6.7%	38.5	1.3	28.1	.89
Cost/Price Analyst	2	55 26.2%	37.6	1.43	28.3	.68
Contract Negotiator	3	8 3.8%	36.9	1.46	27.5	1.00
Contracting Officer	4	49 23.3%	37.1	1.47	28.5	.56
Program Staff	5	5 2.4%	37.8	1.47	28.6	.49
Program Manager	6	7 3.3%	38.4	1.18	27.9	.99
Engineer	7	12 5.7%	38.8	1.09	28.1	.90
Legal Support	8	0				
Technical Support	9	5 2.4%	38.6	1.20	28.2	.75
Auditor	10	46 21.2%	36.5	.95	28.6	.53
Accounting	11	2 1%	38.0	2.00	27.5	.5
Other		7 3.3%				
Industry Size						
<$100 Million	12	2 1%	38.0	1.00	28.0	
$100 - $500 Million	13	8 3.8%	38.6	1.26	28.2	.79
$500 Million - $1 Billion	14	1 .5%	39.0			
> $1 Billion	15	9 4.3%	39.0	1.00	28.3	.66
Total Industry		20 10%				

Group Name	Sort Code	# of Responses		Math Sort Code μ	Math Sort Code σ	Experience Sort Code μ	Experience Sort Code σ
Government							
U.S. Army	16	52	24.9%	37.7	1.59	28.4	.72
DCMC	17	35	16.8%	37.1	1.36	26.1	.73
DCAA	18	49	22.9%	36.6	1.06	28.6	.58
NASA	19	9	4.4%	38.0	1.41	28.0	1.00
U.S. Navy	20	22	10.6%	37.3	1.33	28.2	.89
USAF	21	17	8.2%	37.9	1.49	28.2	.76
GSA	22	1	.6%	37.0		28.0	
OSD		2	1%				
DoE		2	1%				
Total Government		189	90%				
Level/Rank							
GS 12/O3		7	3.7%				
GS 13/O4		19	9.1%				
GS 14/O5		24	11.4%				
GS 15/O6		25	11.5%				
Experience							
Cost Estimating Community	23	40	19.1%	37.2	1.43	28.0	.81
Acquisition Community	24	102	48.6%	38.0	1.54	28.5	.50
One Year or Less	25	0					
One to Five Years	26	5	2.3%	37.4	.80		
Five to Ten Years	27	19	9.1%	37.8	1.54		
Ten to Twenty Years	28	85	40.5%	37.6	1.57		

Group Name	Sort Code	# of Responses	Math Sort Code μ	Math Sort Code σ	Experience Sort Code μ	Experience Sort Code σ
Over Twenty Years	29	97 46.2%	37.2	1.41		
Work Description						
Prepare Estimates	30	37 17.6%	38.1	.70	28.1	.91
Negotiation Preparation	31	101 48.1%	37.2	1.46	28.3	.73
Review/Audit Estimates	32	103 49.1%	37.4	1.52	28.4	.65
Set Corporate Policy	33	2.4%	39.0	1.26	28.0	.63
Set Government Policy	34	28 13.3%	38.2	1.54	28.3	.76
Mathematics Knowledge						
High School Algebra/Calculus	35	24 11.4%			28.3	.55
College Algebra	36	64 30.5%			28.5	.58
College Business Calculus	37	69 32.9%			28.2	.80
College Engineering Calculus	38	34 16.2%			28.2	.82
College Mathematics Major or Minor	39	31 14.8%			28.6	.67
Advanced Degree With Mathematics	40	28 13.3%			28.1	.65

SURVEY DISTRIBUTION AND RETURN DATA

Group Name	# Surveys Sent	# Incorrect Addresses	# Surveys Returned	% of Surveys Sent	Group Response Rate	% of Surveys Returned
U.S. Army	332	4	52	26.1	15.9	24.9
DCMC	203	0	35	16.1	17.2	16.8

Group Name	# Surveys Sent	# Incorrect Addresses	# Surveys Returned	% of Surveys Sent	Group Response Rate	% of Surveys Returned
DCAA	525	131	49	31.2	12.2	22.9
NASA	39	0	9	3.0	23.1	4.4
U.S. Navy	120	0	22	9.5	18.3	10.6
USAF	80	10	17	5.6	24.3	8.2
GSA	9	0	1	.7	11.1	.6
DoE	55	0	2	4.4	3.6	1
OSD	11	0	2	.9	18.2	1
Industry	33	0	20	2.5	64.5	9.6
Total	1407	145	209	100	Avg 16.5	100

TOTAL GROUP DATA

	Responses												
	No Ans	#1	2	3	4	5		Avg	Std Dev	Var	Med	Skew
QUESTION 1:												
Bench Marking Process Costs	76	14	42	56	21	1		2.66	.89	.75	3.00	-0.14
Validating Bottom's Up Estimates	50	17	52	71	17	3		2.61	.88	.78	3.00	-0.22
Program Estimates	54	29	64	56	7	0		2.25	.82	.81	2.00	-0.21
Budgeting	48	37	68	48	9	0		2.20	.85	.60	2.00	-0.35
ICE Generation	90	25	41	39	15	0		2.34	.95	.48	2.00	-0.37
Software Contracts	71	27	29	54	27	2		2.54	1.06	.84	3.00	-0.59
Repair Parts	66	8	34	72	30	0		2.85	.80	1.27	3.00	0.00
R & D	57	18	41	49	40	5		2.83	1.06	.76	3.00	-0.56
Service	58	8	29	57	57	1		3.09	.89	.77	3.00	-0.79
Hardware	47	29	56	59	19	0		2.55	.85	.85	3.00	-0.64
Construction	79	11	41	54	25	0		2.71	.88	.48	3.00	-0.65
Commodity	101	3	13	51	41	1		3.23	.78	.64	3.00	0.65
QUESTION 2:												
CE	45	39	48	43	33	2		2.46	1.09	1.27	2.00	0.89
PDR&R	40	30	60	58	21	1		2.43	.95	.80	2.00	0.43
E&MD	40	22	62	76	10	0		2.45	.82	.41	3.00	-0.59
PFD&OS	42	19	52	70	27	0		2.65	.89	.48	3.00	-0.05
QUESTION 3:												
FFP	52	19	55	60	23	1		2.56	.90	1.22	3.00	0.60
FPE	81	12	38	53	25	1		2.71	.90	1.22	3.00	0.60
FPIS	83	11	42	59	15	0		2.62	.81	1.04	3.00	1.02
FPR(P)	77	12	46	60	15	0		2.60	.81	1.04	3.00	1.02
FPR(R)	79	13	42	57	19	0		2.64	.85	1.04	3.00	1.02
FPIF	69	14	52	57	18	0		2.56	.83	1.22	3.00	0.60
CPIF	65	19	43	59	24	0		2.62	.91	.92	3.00	0.54
CPAF	68	20	43	55	23	1		2.59	.95	.92	3.00	0.54
CPFF	65	22	41	59	22	1		2.58	.95	.92	3.00	0.54
T & M	69	7	26	53	49	6		3.13	.97	.50	3.00	0.94
LABOR HOUR	73	5	30	47	49	6		3.16	.93	.56	3.00	0.62

	No Ans	#1	2	3	4	5		Avg	Std Dev	Var	Med	Skew
QUESTION 4:												
PRE-AWARD	32	32	64	69	13	0		2.63	.86	.60	2.00	-0.35
POST-AWARD	41	17	32	59	53	8		3.04	1.05	1.26	3.00	-0.50
QUESTION 5:												
A	0	28	62	67	26	27		2.49	.92	.61	3.00	-0.18
B	0	20	82	56	15	37		2.37	.81	.43	2.00	-1.32
C	0	45	97	37	8	23		2.04	.79	.55	2.00	0.00
D	0	34	103	35	11	27		2.15	.83	1.17	2.00	0.79
E	0	7	43	71	39	50		2.89	.82	.54	3.00	-0.81
F	0	18	99	41	13	39		2.29	.76	.44	2.00	-0.43
QUESTION 6:												
A	0	27	95	40	12	36		2.21	.78	.69	2.00	0.69
B	0	14	49	84	29	34		2.73	.83	.74	3.00	-0.34
C	0	22	89	40	18	41		2.33	.84	.56	2.00	0.00
D	0	24	84	55	13	34		2.35	.80	1.29	2.00	0.23
E	0	26	77	56	15	36		2.37	.83	1.24	2.00	0.50
F	0	36	101	28	9	36		2.06	.76	.32	2.00	-0.77
G	0	13	66	60	20	51		2.55	.80	.89	3.00	-0.89
QUESTION 7:												
A	0	66	95	17	7	25		1.81	.76	.51	2.00	0.33
B	0	64	107	13	3	23		1.75	.65	.23	2.00	-0.66
C	0	71	106	6	3	24		1.67	.61	.23	2.00	-0.66
QUESTION 8:												
A	0	31	90	35	19	35		2.25	.87	.69	2.00	-0.36
B	0	32	93	33	16	36		2.20	.84	.94	2.00	-0.20
C	0	50	102	19	8	31		1.93	.75	1.23	2.00	0.35
D	0	30	99	24	9	48		2.08	.74	.94	2.00	0.23
QUESTION 9:	0	15	82	37	13	63		2.37	.83	.03	2.00	-0.58
QUESTION 10:												
A	0	10	80	66	22	32		2.57	.80	.69	2.00	-0.41
B	0	1	48	84	20	57		2.83	.70	.98	3.00	0.51
C	0	9	66	78	21	36		2.66	.78	.56	3.00	0.57
D	0	20	67	68	16	39		2.48	.85	.65	2.00	-0.65

Control Group Data

	No Response	# 1	# 2	# 3	# 4	# 5		Std Dev	Variation	Median	Skew
Question 1											
Program Est	0	8	1	2	0	0	1.45	0.78	0.61	1	1.50
Budgeting	0	5	4	1	1	0	1.82	0.94	0.88	2	1.20
R&D	1	6	2	2	0	0	1.60	0.80	0.64	1	0.61
Software	2	0	5	2	1	1	2.78	1.03	1.06	2	0.10
Repair Parts	1	4	2	4	0	0	2.00	0.89	0.80	2	(0.15)
Service	2	1	2	1	3	2	3.33	1.33	1.78	4	(0.33)
Hardware	2	2	5	2	0	0	2.00	0.67	0.44	2	(0.45)
Construction	3	2	2	3	1	0	2.38	0.99	0.98	3	0.07
Commodity	5	0	0	2	1	3	4.17	0.90	0.81	5	0.08
Question 2											
CE	0	7	3	1	0	0	1.45	0.66	0.43	1	1.32
PD&RR	0	5	6	0	0	0	1.55	0.50	0.25	2	(0.21)
E&MD	0	4	4	3	0	0	1.91	0.79	0.63	2	0.19
PF/D&OS	0	4	1	2	4	0	2.55	1.30	1.70	3	(0.12)
Question 3											
FFP	2	4	3	1	0	1	2.00	1.25	1.56	2	1.28
FPE	4	3	2	1	0	1	2.14	1.36	1.84	2	1.36
FPIS	5	3	1	2	0	0	1.83	0.90	0.81	2	0.89
FPR(P)	5	3	1	2	0	0	1.83	0.90	0.81	2	0.89
FPR(R)	5	3	2	1	0	0	1.67	0.75	0.56	2	0.86
FPIF	3	4	3	1	0	0	1.63	0.70	0.48	2	0.35
CPIF	3	4	4	0	0	0	1.50	0.50	0.25	2	(0.19)
CPAF	3	4	4	0	0	0	1.50	0.50	0.25	2	(0.19)
CPFF	3	5	3	0	0	0	1.38	0.48	0.23	1	0.00
T&M	4	1	1	2	1	2	3.29	1.39	1.92	3	0.29
Labor Hour	5	1	1	1	0	3	3.50	1.61	2.58	4	0.61
Question 4											
Pre-Award	2	9	0	0	0	0	1.00	0.00	0.00	1	(1.92)
Post-Award	3	7	1	0	0	0	1.13	0.33	0.11	1	0.03

	No Response	# 1	# 2	# 3	# 4	# 5		Std Dev	Variation	Median	Skew
Question 5											
5a	0	7	2	2	0	0	1.55	0.78	0.61	1	1.15
5b	11	0	0	0	0	0	0.00	0.00	0.00	0	0.00
5c	0	8	3	0	0	0	1.27	0.45	0.20	1	1.19
5d	0	3	5	1	0	2	2.36	1.37	1.87	2	1.21
5e	11	0	0	0	0	0	0.00	0.00	0.00	0	0.00
5f	11	0	0	0	0	0	0.00	0.00	0.00	0	0.00
Question 6											
6a	0	0	4	4	3	0	2.91	0.79	0.63	3	0.19
6b	0	0	1	7	3	0	3.18	0.57	0.33	3	(0.03)
6c	11	0	0	0	0	0	0.00	0.00	0.00	0	0.00
6d	1	1	1	6	2	0	2.90	0.83	0.69	3	(1.23)
6e	1	1	3	4	2	0	2.70	0.90	0.81	3	(0.69)
6f	0	1	6	3	1	0	2.36	0.77	0.60	2	0.54
6g	11	0	0	0	0	0	0.00	0.00	0.00	0	0.00
Question 7											
7a	0	3	5	1	2	0	2.18	1.03	1.06	2	0.74
7b	0	4	6	1	0	0	1.73	0.62	0.38	2	0.29
7c	0	4	6	1	0	0	1.73	0.62	0.38	2	0.29
Question 8											
8a	0	0	5	4	2	0	2.73	0.75	0.56	3	0.57
8b	0	2	7	2	0	0	2.00	0.60	0.36	2	0.00
8c	0	4	2	5	0	0	2.09	0.90	0.81	2	(0.21)
8d	11	0	0	0	0	0	0.00	0.00	0.00	0	0.00
Question 9											
9	0	1	4	3	2	1	2.82	1.11	1.24	3	0.42
Question 10											
10a	0	1	5	2	1	2	2.82	1.27	1.60	2	0.71
10b	11	0	0	0	0	0	0.00	0.00	0.00	0	0.00
10c	1	2	6	2	0	0	2.00	0.63	0.40	2	(0.69)
10d	1	0	2	5	3	0	3.10	0.70	0.49	3	(1.42)

Cost Estimator Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	4	2	3	3	2	0	2.50	1.02	1.05	3	0.09
Validating	0	1	6	5	1	1	2.64	0.97	0.94	3	0.86
Program Est	2	3	4	4	1	0	2.25	0.92	0.85	2	(0.15)
Budgeting	1	4	5	4	0	0	2.00	0.78	0.62	2	(0.31)
ICE	3	1	4	5	1	0	2.55	0.78	0.61	3	(0.49)
Software	3	2	2	4	2	1	2.82	1.19	1.42	3	(0.03)
Repair Parts	5	1	1	1	6	0	3.33	1.05	1.11	4	(0.16)
R&D	2	3	2	6	1	0	2.42	0.95	0.91	3	(0.42)
Service	3	1	1	5	4	0	3.09	0.90	0.81	3	(0.70)
Hardware	2	3	5	2	0	0	1.90	0.95	0.91	3	(0.46)
Construction	3	1	1	8	1	0	2.82	0.72	0.51	3	(0.87)
Commodity	7	1	1	4	1	0	2.71	0.88	0.78	3	0.46
Question 2											
CE	0	6	5	1	2	0	1.93	1.03	1.07	2	1.04
PD&RR	1	3	6	2	2	0	2.23	0.97	0.95	2	0.20
E&MD	1	1	7	5	0	0	2.31	0.61	0.37	2	(1.14)
PFD&OS	1	0	3	7	3	0	3.00	0.63	0.40	3	(1.52)
Question 3											
FFP	7	1	2	1	3	0	2.86	1.12	1.27	3	0.64
FPE	7	1	2	1	3	0	2.86	1.12	1.27	3	0.64
FPIS	8	1	2	1	2	0	2.67	1.11	1.22	3	1.00
FPR(P)	7	1	2	1	2	0	2.67	1.11	1.22	3	1.00
FPR(R)	8	1	2	1	2	0	2.67	1.11	1.22	3	1.00
FPIF	7	1	2	1	3	0	2.86	1.12	1.27	3	0.64
CPIF	7	1	2	2	2	0	2.71	1.03	1.06	3	0.63
CPAF	7	1	2	2	2	0	2.71	1.03	1.06	3	0.63
CPFF	7	1	2	2	2	0	2.71	1.03	1.06	3	0.63
T&M	8	0	1	2	3	0	3.33	0.75	0.56	4	0.56
Labor Hour	7	0	2	2	3	0	3.14	0.83	0.69	3	0.37
Question 4											
Pre-Award	1	4	4	5	0	0	2.08	0.83	0.69	2	(0.38)
Post-Award	1	2	2	3	5	1	3.08	1.18	1.40	3	(0.56)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	0	1	5	7	1	0	2.57	0.73	0.53	3	(0.28)
5b	0	1	5	8	0	0	2.50	0.63	0.39	3	(0.98)
5c	0	4	5	5	0	0	2.07	0.80	0.64	2	(0.14)
5d	0	4	6	2	2	0	2.14	0.99	0.98	2	0.67
5e	2	0	3	5	4	0	3.08	0.76	0.58	3	(1.03)
5f	1	0	8	3	2	0	2.54	0.75	0.56	2	(0.33)
Question 6											
6a	1	2	6	4	1	0	2.31	0.82	0.67	2	(0.32)
6b	1	1	3	7	2	0	2.77	0.80	0.64	3	(1.05)
6c	2	1	9	1	1	0	2.17	0.69	0.47	2	(0.17)
6d	0	4	3	4	3	0	2.43	1.12	1.24	3	0.03
6e	4	6	2	2	0		1.60	0.99	0.98	2	0.67
6f	4	1	6	3	0	0	2.20	0.60	0.36	2	(0.38)
6g	1	1	3	6	3	0	2.85	0.86	0.75	3	(0.94)
Question 7											
7a	2	4	6	2	0	0	1.83	0.69	0.47	2	(0.24)
7b	2	4	8	0	0	0	1.67	0.47	0.22	2	(0.97)
7c	2	4	8	0	0	0	1.67	0.47	0.22	2	(0.97)
Question 8											
8a	3	1	5	3	2	0	2.55	0.89	0.79	2	(0.21)
8b	4	1	3	3	3	0	2.80	0.98	0.96	3	(0.14)
8c	4	2	4	1	3	0	2.50	1.12	1.25	2	0.27
8d	5	2	4	2	1	0	2.22	0.92	0.84	2	0.40
Question 9											
9	5	0	7	1	1	0	2.33	0.63	0.40	2	0.13
Question 10											
10a	0	0	4	4	6	0	3.14	0.83	0.69	3	(0.31)
10b	0	1	6	3	4	0	2.71	0.96	0.92	3	0.12
10c	1	0	5	6	2	0	2.77	0.70	0.49	3	(0.99)
10d	1	1	6	4	2	0	2.54	0.84	0.71	2	(0.42)

Cost/Price Analyst Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	26	1	13	12	6	1	2.79	0.88	0.77	3	0.20
Validating	19	1	13	19	7	0	2.80	0.75	0.56	3	(0.39)
Program Est	19	5	22	12	1	0	2.23	0.69	0.47	2	(0.22)
Budgeting	14	7	23	13	2	0	2.22	0.76	0.57	2	(0.31)
ICE	20	7	13	11	8	0	2.51	1.01	1.02	2	0.09
Software	20	6	11	15	7	0	2.59	0.95	0.91	3	(0.05)
Repair Parts	18	2	9	21	9	0	2.90	0.79	0.62	3	(0.49)
R&D	14	5	13	13	12	2	2.84	1.07	1.15	3	(0.24)
Service	16	2	4	19	18	0	3.23	0.80	0.64	3	(0.77)
Hardware	14	5	10	24	6	0	2.69	0.84	0.70	3	(0.60)
Construction	22	4	9	14	10	0	2.81	0.95	0.91	3	(0.06)
Commodity	25	1	5	14	14	0	3.21	0.80	0.63	3	(0.14)
Question 2											
CE	15	10	17	10	6	1	2.34	1.03	1.06	2	0.18
PD&RR	13	8	19	10	8	1	2.46	1.04	1.07	2	0.05
E&MD	11	6	19	18	5	0	2.46	0.82	0.68	2	(0.49)
PFD&OS	12	7	13	20	7	0	2.57	0.92	0.84	3	(0.45)
Question 3											
FFP	12	9	12	18	7	1	2.55	1.03	1.06	3	(0.20)
FPE	20	5	5	18	7	1	2.84	0.97	0.95	3	(0.05)
FPIS	23	4	10	19	3	0	2.58	0.79	0.63	3	(0.09)
FPR(P)	20	5	9	21	4	0	2.62	0.84	0.70	3	(0.24)
FPR(R)	21	5	7	20	6	0	2.71	0.89	0.78	3	(0.17)
FPIF	20	5	10	18	6	0	2.64	0.89	0.79	3	(0.16)
CPIF	15	5	10	20	9	0	2.75	0.91	0.82	3	(0.46)
CPAF	17	6	12	16	7	1	2.64	1.00	0.95	3	(0.11)
CPFF	16	7	13	15	7	1	2.58	1.02	1.03	3	(0.07)
T&M	18	3	4	17	13	4	3.27	1.01	1.03	3	(0.37)
Labor Hour	20	3	6	14	12	4	3.21	1.07	1.14	3	(0.17)
Question 4											
Pre-Award	10	11	17	15	6	0	2.33	0.96	0.91	2	(0.15)
Post-Award	13	8	7	17	13	1	2.83	1.09	1.19	3	(0.37)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	9	8	15	16	11	0	2.60	1.00	1.00	3	(0.36)
5b	14	2	19	18	6	0	2.62	0.77	0.59	3	(0.53)
5c	11	24	13	4	0		1.51	0.86	0.73	2	(0.03)
5d	8	9	28	10	3	1	2.20	0.86	0.75	2	0.25
5e	18	1	11	16	13	0	3.00	0.83	0.68	3	(0.45)
5f	15	6	19	14	5	0	2.41	0.86	0.74	2	(0.22)
Question 6											
6a	16	4	24	12	3	0	2.33	0.74	0.55	2	(0.28)
6b	12	2	14	20	11	0	2.85	0.82	0.68	3	(0.72)
6c	14	5	25	12	3	0	2.29	0.75	0.56	2	(0.31)
6d	9	4	19	22	5	0	2.56	0.78	0.61	3	(0.70)
6e	11	7	16	20	5	0	2.48	0.87	0.75	3	(0.48)
6f	13	6	26	10	4	0	2.26	0.79	0.63	2	(0.19)
6g	5	20	13	5	0	0	1.61	0.84	0.71	2	(0.19)
Question 7											
7a	8	20	27	2	2	0	1.73	0.72	0.51	2	0.48
7b	8	18	29	4	0	0	1.73	0.60	0.36	2	(0.36)
7c	9	18	31	1	0	0	1.66	0.51	0.26	2	(0.73)
Question 8											
8a	9	6	29	7	8	0	2.34	0.89	0.78	2	0.01
8b	9	6	34	7	3	0	2.14	0.69	0.48	2	(0.19)
8c	8	16	27	5	3	0	1.90	0.80	0.64	2	0.35
8d	15	9	25	6	4	0	2.11	0.83	0.69	2	0.10
Question 9											
9	16	4	17	14	7	1	2.63	0.94	0.88	3	(0.15)
Question 10											
10a	11	3	19	22	4	0	2.56	0.73	0.54	3	(0.75)
10b	20	0	11	22	6	0	2.87	0.65	0.42	3	(0.46)
10c	11	3	20	20	5	0	2.56	0.76	0.58	3	(0.65)
10d	12	10	12	19	6	0	2.45	0.96	0.93	3	(0.30)

Contract Negotiator Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	5	0	1	2	0	0	2.67	0.47	0.22	3	0.81
Validating	4	0	2	2	0	0	2.50	0.50	0.25	3	0.27
Program Est	4	2	2	0	0	0	1.50	0.50	0.25	2	0.62
Budgeting	4	3	1	0	0	0	1.25	0.43	0.19	1	0.82
ICE	4	1	0	3	0	0	2.50	0.87	0.75	3	0.48
Software	3	2	0	3	0	0	2.20	0.98	0.96	3	0.34
Repair Parts	4	1	1	2	0	0	2.25	0.83	0.69	3	0.62
R&D	2	2	1	1	2	0	2.50	1.26	1.58	3	0.26
Service	2	1	3	1	1	0	2.33	0.94	0.89	2	0.16
Hardware	3	2	2	1	0	0	1.80	0.75	0.56	2	0.49
Construction	4	1	3	0	0	0	1.75	0.43	0.19	2	0.31
Commodity	5	0	0	1	2	0	3.67	0.47	0.22	4	0.74
Question 2											
CE	2	1	2	2	1	0	2.50	0.96	0.92	3	(0.09)
PD&RR	2	2	1	2	1	0	2.33	1.11	1.22	3	0.22
E&MD	1	2	2	2	1	0	2.29	1.03	1.06	2	0.00
PFD&OS	2	2	1	1	2	0	2.50	1.26	1.58	3	0.26
Question 3											
FFP	2	1	1	4	0	0	2.50	0.76	0.58	3	(0.62)
FPE	4	1	1	2	0	0	2.25	0.83	0.69	3	0.62
FPIS	4	1	1	2	0	0	2.25	0.83	0.69	3	0.62
FPR(P)	4	1	1	2	0	0	2.25	0.83	0.69	3	0.62
FPR(R)	4	1	1	2	0	0	2.25	0.83	0.69	3	0.62
FPIF	4	1	1	2	0	0	2.25	0.83	0.69	3	0.62
CPIF	4	2	2	0	0	0	1.50	0.50	0.25	2	0.62
CPAF	3	2	2	1	0	0	1.80	0.75	0.56	2	0.49
CPFF	3	2	2	0	1	0	2.00	1.10	1.20	2	1.12
T&M	3	1	2	2	0	0	2.20	0.75	0.56	2	0.11
Labor Hour	4	1	2	0	1	0	2.25	1.09	1.19	2	1.19
Question 4											
Pre-Award	1	1	2	2	2	0	2.71	1.03	1.06	3	(0.48)
Post-Award	2	1	2	1	1	1	2.83	1.34	1.81	3	0.34

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	2	0	3	3	0	0	2.50	0.50	0.25	3	(0.88)
5b	2	1	4	0	1	0	2.17	0.90	0.81	2	0.41
5c	1	3	2	2	0	0	1.86	0.83	0.69	2	0.04
5d	1	1	4	2	0	0	2.14	0.64	0.41	2	(0.86)
5e	3	1	2	1	1	0	2.40	1.02	1.04	2	0.50
5f	2	0	6	0	0	0	2.00	0.00	0.00	2	(1.44)
Question 6											
6a	1	1	5	1	0	0	2.00	0.53	0.29	2	(1.03)
6b	2	1	2	2	1	0	2.50	0.96	0.92	3	(0.09)
6c	2	1	2	2	1	0	2.50	0.96	0.92	3	(0.09)
6d	2	2	4	0	0	0	1.67	0.47	0.22	2	(0.62)
6e	2	2	4	0	0	0	1.67	0.47	0.22	2	(0.62)
6f	2	3	0	3	0	0	2.00	1.00	1.00	2	0.25
6g	3	1	2	2	0	0	2.20	0.75	0.56	2	0.11
Question 7											
7a	2	2	3	0	1	0	2.00	1.00	1.00	2	0.76
7c	2	2	3	1	0	0	1.83	0.64	0.41	2	(0.27)
7c	2	2	3	1	0	0	1.83	0.69	0.47	2	(0.04)
Question 8											
8a	2	1	2	2	1	0	2.50	0.96	0.92	3	(0.09)
8b	2	1	2	2	1	0	2.50	0.96	0.92	3	(0.09)
8c	2	0	4	1	1	0	2.50	0.76	0.58	2	(0.16)
8d	2	0	4	1	1	0	2.50	0.76	0.58	2	(0.16)
Question 9											
9	2	0	3	2	1	0	2.67	0.75	0.56	3	(0.40)
Question 10											
10a	1	0	5	1	1	0	2.43	0.73	0.53	2	(0.31)
10b	1	0	3	2	2	0	2.86	0.83	0.69	3	(0.76)
10c	2	1	2	3	0	0	2.33	0.75	0.56	3	(0.47)
10d	2	1	3	1	1	0	2.33	0.94	0.89	2	0.16

Contracting Officer Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	18	1	11	16	3	0	2.68	0.69	0.48	3	(0.11)
Validating	13	2	11	21	2	0	2.64	0.67	0.45	3	(0.52)
Program Est	12	3	18	15	1	0	2.38	0.67	0.45	2	(0.44)
Budgeting	13	5	18	11	2	0	2.28	0.77	0.59	2	(0.13)
ICE	22	1	14	10	2	0	2.48	0.69	0.47	2	0.24
Software	22	4	10	8	5	0	2.52	0.96	0.92	2	0.46
Repair Parts	16	0	8	22	3	0	2.85	0.56	0.31	3	(0.43)
R&D	17	3	11	11	6	1	2.72	0.98	0.95	3	0.14
Service	16	1	8	11	12	1	3.12	0.91	0.83	3	(0.17)
Hardware	9	0	17	20	3	0	2.65	0.61	0.38	3	(0.81)
Construction	25	0	10	9	5	0	2.79	0.76	0.58	3	0.44
Commodity	26	0	3	12	8	0	3.22	0.66	0.43	3	0.34
Question 2											
CE	12	8	6	15	7	1	2.65	1.10	1.20	3	(0.04)
PD&RR	12	3	11	21	2	0	2.59	0.72	0.51	3	(0.53)
E&MD	12	2	16	17	2	0	2.51	0.68	0.47	3	(0.47)
PFD&OS	11	1	15	17	5	0	2.68	0.73	0.53	3	(0.51)
Question 3											
FFP	9	4	15	15	6	0	2.58	0.86	0.74	3	(0.39)
FPE	14	1	13	14	7	0	2.77	0.80	0.63	3	(0.27)
FPIS	16	0	13	16	4	0	2.73	0.66	0.44	3	(0.26)
FPR(P)	15	0	13	17	4	0	2.74	0.66	0.43	3	(0.35)
FPR(R)	16	0	13	15	5	0	2.76	0.70	0.49	3	(0.23)
FPIF	13	0	17	15	4	0	2.64	0.67	0.45	3	(0.40)
CPIF	15	2	11	16	5	0	2.71	0.79	0.62	3	(0.23)
CPAF	13	2	11	16	5	0	2.72	0.77	0.59	3	(0.39)
CPFF	13	3	9	20	4	0	2.69	0.78	0.60	3	(0.41)
T&M	15	0	8	14	11	1	3.15	0.81	0.65	3	(0.31)
Labor Hour	14	0	10	12	12	1	3.11	0.85	0.73	3	(0.32)
Question 4											
Pre-Award	9	3	15	19	3	0	2.55	0.74	0.55	3	(0.61)
Post-Award	11	0	10	14	14	0	3.11	0.79	0.62	3	(0.63)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	10	3	17	15	4	0	2.51	0.78	0.61	2	(0.41)
5b	10	2	20	14	3	0	2.46	0.71	0.50	2	(0.46)
5c	8	7	24	9	1	0	2.10	0.69	0.48	2	(0.36)
5d	11	1	29	5	3	0	2.26	0.64	0.40	2	(0.25)
5e	11	0	5	23	10	0	3.13	0.61	0.38	3	(0.86)
5f	9	0	26	13	1	0	2.38	0.53	0.28	2	(0.78)
Question 6											
6a	11	6	22	6	4	0	2.21	0.83	0.69	2	0.04
6b	9	3	12	21	4	0	2.65	0.76	0.58	3	(0.66)
6c	9	4	22	10	4	0	2.35	0.79	0.63	2	(0.24)
6d	11	1	21	12	4	0	2.50	0.72	0.51	2	(0.37)
6e	10	4	19	14	2	0	2.36	0.73	0.54	2	(0.41)
6f	10	6	29	2	2	0	2.00	0.64	0.41	2	(0.13)
6g	11	2	18	14	4	0	2.53	0.75	0.57	2	(0.38)
Question 7											
7a	8	10	28	3	0	0	1.83	0.54	0.29	2	(0.64)
7b	8	12	27	2	0	0	1.76	0.53	0.28	2	(0.61)
7c	8	14	26	1	0	0	1.68	0.52	0.27	2	(0.61)
Question 8											
8a	10	7	24	7	1	0	2.05	0.68	0.46	2	(0.25)
8b	10	7	25	7	0	0	2.00	0.60	0.36	2	(0.48)
8c	9	11	25	4	0	0	1.83	0.59	0.34	2	(0.43)
8d	12	6	27	4	0	0	1.95	0.52	0.27	2	(0.50)
Question 9	16	3	23	5	2	0	2.18	0.67	0.45	2	0.04
9											
Question 10											
10a	11	2	16	17	3	0	2.55	0.71	0.51	3	(0.49)
10b	14	0	8	22	5	0	2.91	0.60	0.36	3	(0.55)
10c	12	1	7	22	7	0	2.95	0.70	0.48	3	(0.64)
10d	11	4	19	13	2	0	2.34	0.74	0.54	2	(0.33)

Program Staff Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	3	0	0	1	0	0	3.00	0.00	0.00	3	2.00
Validating	1	0	0	3	0	0	3.00	0.00	0.00	3	(2.00)
Program Est	1	0	0	3	0	0	3.00	0.00	0.00	3	(2.00)
Budgeting	1	0	0	3	0	0	3.00	0.00	0.00	3	(2.00)
ICE	2	0	1	1	0	0	2.50	0.50	0.25	3	0.37
Software	1	0	1	1	1	0	3.00	0.82	0.67	3	(0.75)
Repair Parts	2	0	0	1	1	0	3.50	0.50	0.25	4	0.20
R&D	1	0	0	2	1	0	3.33	0.47	0.22	3	(1.54)
Service	2	0	0	1	1	0	3.50	0.50	0.25	4	0.20
Hardware	1	0	0	2	1	0	3.33	0.47	0.22	3	(1.54)
Construction	3	0	0	1	0	0	3.00	0.00	0.00	3	2.00
Commodity	3	0	0	1	0	0	3.00	0.00	0.00	3	2.00
Question 2											
CE	2	0	2	0	0	0	2.00	0.00	0.00	2	0.00
PD&RR	2	0	2	0	0	0	2.00	0.00	0.00	2	0.00
E&MD	2	0	0	2	0	0	3.00	0.00	0.00	3	0.00
PFD&OS	0	0	0	1	3	0	3.75	0.43	0.19	4	(2.00)
Question 3											
FFP	2	0	1	1	0	0	2.50	0.50	0.25	3	0.37
FPE	3	0	0	1	0	0	3.00	0.00	0.00	3	2.00
FPIS	3	0	0	1	0	0	3.00	0.00	0.00	3	2.00
FPR(P)	3	0	0	1	0	0	3.00	0.00	0.00	3	2.00
FPR(R)	3	0	0	1	0	0	3.00	0.00	0.00	3	2.00
FPIF	2	0	1	1	0	0	2.50	0.50	0.25	3	0.37
CPIF	2	0	1	0	1	0	3.00	1.00	1.00	3	0.85
CPAF	2	0	1	0	1	0	3.00	1.00	1.00	3	0.85
CPFF	2	0	1	0	1	0	3.00	1.00	1.00	3	0.85
T&M	2	0	0	0	2	0	4.00	0.00	0.00	4	0.00
Labor Hour	2	0	0	0	2	0	4.00	0.00	0.00	4	0.00
Question 4											
Pre-Award	1	0	0	3	0	0	3.00	0.00	0.00	3	(2.00)
Post-Award	1	0	0	1	2	0	3.67	0.47	0.22	4	(1.66)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	0	0	0	1	3	0	3.75	0.43	0.19	4	(2.00)
5b	1	0	0	2	1	0	3.33	0.47	0.22	3	(1.54)
5c	1	0	2	0	1	0	2.67	0.94	0.89	2	0.00
5d	0	0	2	1	1	0	2.75	0.83	0.69	3	0.85
5e	0	0	2	0	2	0	3.00	1.00	1.00	3	0.00
5f	0	0	3	1	0	0	2.25	0.43	0.19	2	2.00
Question 6											
6a	1	0	1	2	0	0	2.67	0.47	0.22	3	(1.41)
6b	0	0	2	2	0	0	2.50	0.50	0.25	3	0.00
6c	0	1	1	2	0	0	2.25	0.83	0.69	3	(0.85)
6d	0	0	3	1	0	0	2.25	0.43	0.19	2	2.00
6e	0	0	2	2	0	0	2.50	0.50	0.25	3	0.00
6f	0	2	2	0	0	0	1.50	0.50	0.25	2	0.00
6g	1	0	1	2	0	0	2.67	0.47	0.22	3	(1.41)
Question 7											
7a	0	0	2	2	0	0	2.50	0.50	0.25	3	0.00
7b	0	1	2	1	0	0	2.00	0.71	0.50	2	0.00
7c	0	0	4	0	0	0	2.00	0.00	0.00	2	0.00
Question 8											
8a	0	0	4	0	0	0	2.00	0.00	0.00	2	0.00
8b	0	0	4	0	0	0	2.00	0.00	0.00	2	0.00
8c	0	0	4	0	0	0	2.00	0.00	0.00	2	0.00
8d	0	0	4	0	0	0	2.00	0.00	0.00	2	0.00
Question 9											
9	2	0	1	1	0	0	2.50	0.50	0.25	3	0.37
Question 10											
10a	1	0	0	3	0	0	3.00	0.00	0.00	3	(2.00)
10b	2	0	1	1	0	0	2.50	0.50	0.25	3	0.37
10c	0	0	3	1	0	0	2.25	0.43	0.19	2	2.00
10d	2	0	0	2	0	0	3.00	0.00	0.00	3	0.00

Program Manager Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	1	4	1	1	0	0	1.50	0.76	0.58	1	0.86
Validating	1	3	1	1	1	0	2.00	1.15	1.33	2	0.71
Program Est	0	6	0	1	0	0	1.29	0.70	0.49	1	2.65
Budgeting	0	4	2	1	0	0	1.57	0.73	0.53	1	1.11
ICE	1	3	0	3	0	0	2.00	1.00	1.00	2	0.03
Software	1	1	3	2	0	0	2.17	0.69	0.47	2	(0.77)
Repair Parts	2	1	2	1	1	0	2.40	1.02	1.04	2	0.26
R&D	2	0	3	1	1	0	2.60	0.80	0.64	2	(0.11)
Service	1	0	0	32	0	0	3.00	0.69	0.47	3	(1.42)
Hardware	2	2	1	3	0	0	2.17	0.89	0.80	2	0.22
Construction	0	2	1	4	0	0	2.29	0.88	0.78	3	(0.76)
Commodity	2	0	0	4	1	0	3.20	0.40	0.16	3	(0.98)
Question 2											
CE	0	4	1	1	1	0	1.86	1.12	1.27	1	1.15
PD&RR	0	4	1	1	1	0	1.86	1.03	1.06	1	1.78
E&MD	0	2	2	2	1	0	2.29	1.03	1.06	2	0.25
PFD&OS	1	2	4	0	0	0	1.67	0.90	0.81	3	(0.60)
Question 3											
FFP	1	1	2	3	0	0	2.33	0.75	0.56	3	(0.91)
FPE	3	1	1	2	0	0	2.25	0.63	0.69	3	0.36
FPIS	2	1	2	2	0	0	2.20	0.75	0.56	2	(0.22)
FPR(P)	2	1	2	2	0	0	2.20	0.75	0.56	2	(0.22)
FPR(R)	2	1	3	1	0	0	2.00	0.63	0.40	2	(0.24)
FPIF	2	1	3	1	0	0	2.00	0.63	0.40	2	(0.24)
CPIF	2	2	2	1	0	0	1.80	0.75	0.56	2	0.25
CPAF	2	2	2	1	0	0	1.80	0.75	0.56	2	0.25
CPFF	2	2	2	1	0	0	1.80	0.75	0.56	2	0.25
T&M	1	2	1	2	1	0	2.33	1.11	1.22	3	0.00
Labor Hour	2	0	1	3	1	0	3.00	0.63	0.40	3	(0.68)
Question 4											
Pre-Award	0	4	2	0	0	0	1.33	0.73	0.53	1	1.11
Post-Award	0	2	2	2	0	0	2.00	0.83	0.69	2	(0.35)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	0	3	2	1	1	0	2.00	1.07	1.14	2	0.91
5b	0	3	2	0	2	0	2.14	1.25	1.55	2	0.80
5c	0	3	2	1	1	0	2.00	1.07	1.14	2	0.91
5d	0	4	1	2	0	0	1.71	0.88	0.78	1	0.76
5e	0	3	3	0	1	0	1.86	0.99	0.98	2	1.52
5f	1	3	2	0	1	0	1.83	1.07	1.14	2	1.14
Question 6											
6a	0	4	2	0	1	0	1.71	1.03	1.06	1	1.78
6b	0	3	1	2	1	0	2.14	1.12	1.27	2	0.41
6c	1	1	2	2	1	0	2.50	0.96	0.92	3	(0.35)
6d	0	2	4	1	0	0	1.86	0.64	0.41	2	0.17
6e	0	2	4	1	0	0	1.86	0.64	0.41	2	0.17
6f	0	1	6	0	0	0	1.86	0.35	0.12	2	(2.65)
6g	1	0	3	1	2	0	2.83	0.90	0.81	3	(0.57)
Question 7											
7a	1	3	0	0	3	0	2.50	1.50	2.25	3	0.21
7b	0	3	2	0	2	0	2.14	1.25	1.55	2	0.80
7c	0	4	1	0	2	0	2.00	1.31	1.71	1	0.89
Question 8											
8a	2	1	2	1	1	0	2.40	1.02	1.04	2	0.26
8b	1	1	2	1	2	0	2.67	1.11	1.22	3	(0.26)
8c	1	1	5	0	0	0	1.83	0.37	0.14	2	(1.76)
8d	1	0	6	0	0	0	2.00	0.00	0.00	2	(2.65)
Question 9											
9	1	2	4	0	0	0	1.67	0.47	0.22	2	(1.11)
Question 10											
10a	1	1	2	1	2	0	2.67	1.11	1.22	3	(0.26)
10b	1	0	2	4	0	0	2.67	0.47	0.22	3	(1.78)
10c	1	1	1	3	1	0	2.67	0.94	0.89	3	(0.71)
10d	1	2	2	1	1	0	2.17	1.07	1.14	2	0.35

Engineer Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	4	1	2	2	3	0	2.88	1.05	1.11	3	0.02
Validating	3	6	1	2	0	0	1.56	0.83	0.69	1	0.81
Program Est	3	4	3	2	0	0	1.78	0.79	0.62	2	0.26
Budgeting	1	7	3	1	0	0	1.45	0.66	0.43	1	0.67
ICE	3	6	2	1	0	0	1.44	0.68	0.47	1	0.71
Software	2	6	1	2	1	0	1.80	1.08	1.16	1	0.85
Repair Parts	3	2	3	4	0	0	2.22	0.79	0.62	2	(0.29)
R&D	3	4	3	2	0	0	1.78	0.79	0.62	2	0.26
Service	2	2	0	5	3	0	2.90	1.04	1.09	3	(0.67)
Hardware	2	4	1	5	0	0	2.10	0.94	0.89	3	(0.16)
Construction	4	2	3	3	0	0	2.13	0.78	0.61	2	0.06
Commodity	5	1	1	3	2	0	2.86	0.99	0.98	3	0.21
Question 2											
CE	1	5	3	2	1	0	1.91	1.00	0.99	2	0.58
PD&RR	1	4	5	2	0	0	1.82	0.72	0.51	2	(0.14)
E&MD	1	5	1	5	0	0	2.00	0.95	0.91	2	(0.09)
PFD&OS	1	3	3	3	2	0	2.36	1.07	1.14	2	(0.05)
Question 3											
FFP	3	3	4	2	0	0	1.89	0.74	0.54	2	(0.00)
FPE	7	3	1	1	0	0	1.60	0.80	0.64	1	1.50
FPIS	7	3	1	1	0	0	1.60	0.80	0.64	1	1.50
FPR(P)	6	3	2	1	0	0	1.67	0.75	0.56	2	0.99
FPR(R)	6	3	2	1	0	0	1.67	0.75	0.56	2	0.99
FPIF	4	5	2	1	0	0	1.50	0.71	0.50	1	0.76
CPIF	4	3	5	0	0	0	1.63	0.48	0.23	2	(0.18)
CPAF	5	3	4	0	0	0	1.57	0.48	0.24	2	0.18
CPFF	4	3	3	2	0	0	1.88	0.78	0.61	2	0.31
T&M	4	1	4	1	2	0	2.50	1.00	1.00	2	0.30
Labor Hour	4	1	4	1	2	0	2.50	1.00	1.00	2	0.30
Question 4											
Pre-Award	2	4	3	3	0	0	1.90	0.83	0.69	2	0.00
Post-Award	2	2	3	4	1	0	2.40	0.92	0.84	3	(0.31)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	1	2	7	2	0	0	2.00	0.60	0.36	2	(0.77)
5b	3	3	3	3	0	0	2.00	0.82	0.67	2	0.00
5c	1	6	5	0	0	0	1.45	0.50	0.25	1	(0.44)
5d	0	5	6	0	0	1	1.83	1.07	1.14	2	2.28
5e	3	1	5	3	0	0	2.22	0.63	0.40	2	(0.49)
5f	3	1	7	1	0	0	2.00	0.47	0.22	2	(0.65)
Question 6											
6a	1	2	5	3	1	0	2.27	0.86	0.74	2	(0.19)
6b	0	1	2	5	4	0	3.00	0.91	0.83	3	(0.76)
6c	3	3	5	1	0	0	1.78	0.63	0.40	2	(0.13)
6d	2	2	4	3	1	0	2.30	0.90	0.81	2	(0.16)
6e	3	1	4	3	1	0	2.44	0.83	0.69	2	(0.19)
6f	0	1	8	2	1	0	2.25	0.72	0.52	2	1.05
6g	3	2	2	4	1	0	2.44	0.96	0.91	3	(0.12)
Question 7											
7a	1	3	6	2	0	0	1.91	0.67	0.45	2	(0.44)
7b	0	3	6	3	0	0	2.00	0.71	0.50	2	0.00
7c	0	4	7	1	0	0	1.75	0.60	0.35	2	0.17
Question 8											
8a	1	2	3	5	1	0	2.45	0.89	0.79	3	(0.58)
8b	2	1	4	4	1	0	2.50	0.81	0.65	3	(0.53)
8c	1	3	5	3	0	0	2.00	0.74	0.55	2	(0.41)
8d	5	0	4	1	2	0	2.71	0.88	0.78	2	0.33
Question 9											
9	3	1	5	3	0	0	2.22	0.63	0.40	2	(0.49)
Question 10											
10a	0	0	7	3	1	1	2.67	0.94	0.89	2	1.50
10b	5	0	3	3	1	0	2.71	0.70	0.49	3	0.10
10c	1	1	5	4	1	0	2.45	0.78	0.61	2	(0.59)
10d	1	0	7	3	1	0	2.45	0.66	0.43	2	(0.59)

Technical Support Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	1	1	1	2	0	0	2.25	0.83	0.69	3	(0.54)
Validating	1	0	2	2	0	0	2.50	0.50	0.25	3	(1.36)
Program Est	0	1	2	1	1	0	2.40	1.02	1.04	2	0.40
Budgeting	0	0	2	3	0	0	2.60	0.49	0.24	3	(0.61)
ICE	4	1	0	0	0	0	1.00	0.00	0.00	1	2.24
Software	1	2	1	0	0	1	2.25	1.64	2.69	2	1.52
Repair Parts	0	0	0	3	1	0	3.25	0.49	0.24	3	0.61
R&D	2	0	0	1	1	1	4.00	0.82	0.67	4	(0.20)
Service	1	0	1	2	1	0	3.00	0.71	0.50	3	(1.12)
Hardware	1	0	1	2	1	0	3.00	0.71	0.50	3	(1.12)
Construction	2	0	0	1	2	0	3.67	0.47	0.22	4	(0.44)
Commodity	3	0	0	0	2	0	4.00	0.00	0.00	4	0.61
Question 2											
CE	1	1	2	0	1	0	2.25	1.09	1.19	2	0.55
PD&RR	0	1	1	2	0	0	2.25	0.83	0.69	3	(0.54)
E&MD	1	0	3	1	0	0	2.25	0.43	0.19	2	(1.29)
PFD&OS	1	0	1	2	1	0	3.00	0.71	0.50	3	(1.12)
Question 3											
FFP	1	0	0	2	2	0	3.50	0.50	0.25	4	(1.74)
FPE	2	0	0	1	2	0	3.67	0.47	0.22	4	(0.44)
FPIS	2	0	0	2	1	0	3.33	0.47	0.22	3	(0.38)
FPR(P)	2	0	0	2	1	0	3.33	0.47	0.22	3	(0.38)
FPR(R)	2	0	0	2	1	0	3.33	0.47	0.22	3	(0.38)
FPIF	2	0	0	2	1	0	3.33	0.47	0.22	3	(0.38)
CPIF	2	0	0	3	0	0	3.00	0.00	0.00	3	(0.61)
CPAF	2	0	0	3	0	0	3.00	0.00	0.00	3	(0.61)
CPFF	2	0	0	3	0	0	3.00	0.00	0.00	3	(0.61)
T&M	2	0	0	2	1	0	3.33	0.47	0.22	3	(0.38)
Labor Hour	2	0	0	2	1	0	3.33	0.47	0.22	3	(0.38)
Question 4											
Pre-Award	1	0	1	3	0	0	2.75	0.43	0.19	3	(1.71)
Post-Award	1	0	1	2	1	0	3.00	0.71	0.50	3	(1.12)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	1	0	2	1	1	0	2.75	0.83	0.69	3	(0.55)
5b	1	0	3	1	0	0	2.25	0.43	0.19	2	(1.29)
5c	2	1	2	0	0	0	1.67	0.47	0.22	2	0.00
5d	1	1	3	0	0	0	1.75	0.43	0.19	2	(1.26)
5e	2	0	1	1	1	0	3.00	0.82	0.67	3	0.05
5f	3	0	2	0	0	0	2.00	0.00	0.00	2	0.61
Question 6											
6a	2	0	2	1	0	0	2.33	0.47	0.22	2	(0.17)
6b	3	0	1	0	1	0	3.00	1.00	1.00	3	1.26
6c	1	1	1	2	0	0	2.25	0.83	0.69	3	(0.54)
6d	2	0	2	1	0	0	2.33	0.47	0.22	2	(0.17)
6e	2	0	2	1	0	0	2.33	0.47	0.22	2	(0.17)
6f	1	2	2	0	0	0	1.50	0.50	0.25	2	(0.51)
6g	3	0	1	1	0	0	2.50	0.50	0.25	3	0.88
Question 7											
7a	1	1	2	1	0	0	2.00	0.71	0.50	2	(0.40)
7c	1	1	3	0	0	0	1.75	0.43	0.19	2	(1.26)
7c	2	1	2	0	0	0	1.67	0.47	0.22	2	0.00
Question 8											
8a	2	1	2	0	1	0	2.25	0.94	0.89	2	0.51
8b	2	0	2	0	1	0	2.67	0.94	0.89	2	0.51
8c	2	0	3	0	0	0	2.00	0.00	0.00	2	(0.61)
8d	2	0	2	1	0	0	2.33	0.47	0.22	2	(0.17)
Question 9											
9	2	0	1	0	1	1	3.67	1.25	1.56	4	0.23
Question 10											
10a	1	0	3	0	1	0	2.50	0.87	0.75	2	0.00
10b	1	0	1	1	0	1	3.33	1.30	1.69	4	(0.52)
10c	1	0	2	1	0	1	3.00	1.22	1.50	3	0.27
10d	2	0	0	1	1	1	4.00	0.82	0.67	4	(0.20)

Auditor Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	14	1	8	16	7	0	2.91	0.76	0.58	3	(0.33)
Validating	10	2	12	15	5	2	2.81	0.94	0.88	3	(0.22)
Program Est	14	1	10	18	3	0	2.72	0.67	0.45	3	(0.37)
Budgeting	17	1	13	11	4	0	2.62	0.76	0.58	3	0.02
ICE	33	1	4	4	4	0	2.85	0.95	0.90	3	1.40
Software	22	1	6	9	8	0	3.00	0.87	0.75	3	0.30
Repair Parts	18	1	7	12	8	0	2.96	0.82	0.68	3	(0.01)
R&D	15	0	4	9	17	1	3.48	0.76	0.57	4	(0.41)
Service	16	1	8	8	13	0	3.10	0.91	0.82	3	(0.13)
Hardware	14	2	15	10	5	0	2.56	0.83	0.68	2	(0.07)
Construction	17	1	10	14	4	0	2.72	0.74	0.54	3	(0.07)
Commodity	23	0	3	12	7	1	3.26	0.74	0.54	3	0.28
Question 2											
CE	14	1	8	9	14	0	3.13	0.89	0.80	3	(0.29)
PD&RR	12	1	10	17	6	0	2.82	0.75	0.56	3	(0.46)
E&MD	14	1	9	18	4	0	2.78	0.70	0.48	3	(0.37)
PFD&OS	15	1	13	14	3	0	2.61	0.70	0.50	3	(0.20)
Question 3											
FFP	15	0	14	12	5	0	2.71	0.73	0.53	3	(0.17)
FPE	18	0	12	11	5	0	2.75	0.74	0.54	3	0.03
FPIS	18	0	10	13	5	0	2.82	0.71	0.50	3	(0.03)
FPR(P)	17	0	13	12	4	0	2.69	0.70	0.49	3	(0.06)
FPR(R)	16	0	11	14	5	0	2.80	0.70	0.49	3	(0.17)
FPIF	15	0	13	14	4	0	2.71	0.68	0.46	3	(0.23)
CPIF	15	0	9	16	6	0	2.90	0.69	0.47	3	(0.30)
CPAF	16	1	8	14	7	0	2.90	0.79	0.62	3	(0.15)
CPFF	15	1	8	16	6	0	2.87	0.75	0.56	3	(0.26)
T&M	15	0	5	11	15	0	3.32	0.74	0.54	3	(0.39)
Labor Hour	16	0	4	13	13	0	3.30	0.69	0.48	3	(0.34)
Question 4											
Pre-Award	11	1	17	15	2	0	2.51	0.65	0.42	2	(0.51)
Post-Award	11	0	1	12	17	5	3.74	0.73	0.53	4	(0.79)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	8	6	8	19	5	0	2.61	0.90	0.82	3	(0.49)
5b	7	5	21	10	3	0	2.28	0.78	0.61	2	(0.28)
5c	7	4	26	8	1	0	2.15	0.62	0.39	2	(0.54)
5d	8	2	21	13	2	0	2.39	0.67	0.45	2	(0.57)
5e	12	0	8	19	7	0	2.97	0.66	0.44	3	(0.59)
5f	7	4	22	9	4	0	2.33	0.80	0.63	2	(0.25)
Question 6											
6a	7	3	25	9	2	0	2.26	0.67	0.45	2	(0.46)
6b	10	2	11	20	3	0	2.67	0.71	0.50	3	(0.64)
6c	10	3	17	9	7	0	2.56	0.90	0.80	2	(0.18)
6d	12	6	20	8	0	0	2.06	0.64	0.41	2	(0.29)
6e	12	6	15	11	2	0	2.26	0.82	0.67	2	(0.08)
6f	9	10	20	6	1	0	1.95	0.73	0.54	2	(0.05)
6g	13	1	14	14	4	0	2.64	0.73	0.53	3	(0.30)
Question 7											
7a	6	18	19	2	1	0	1.65	0.69	0.48	2	0.32
7b	6	13	25	1	1	0	1.75	0.62	0.39	2	(0.07)
7c	6	18	21	0	1	0	1.60	0.62	0.39	2	0.24
Question 8											
8a	8	11	14	9	4	0	2.16	0.96	0.92	2	0.12
8b	8	13	11	9	5	0	2.16	1.04	1.08	2	0.22
8c	6	15	21	3	1	0	1.75	0.70	0.49	2	0.13
8d	6	12	19	8	1	0	1.95	0.77	0.60	2	(0.07)
Question 9											
9	16	5	17	7	1	0	2.13	0.72	0.52	2	0.10
Question 10											
10a	8	2	21	12	3	0	2.42	0.71	0.51	2	(0.48)
10b	13	0	9	22	2	0	2.79	0.54	0.29	3	(0.62)
10c	10	1	17	15	3	0	2.56	0.68	0.47	3	(0.53)
10d	10	0	15	19	2	0	2.64	0.58	0.34	3	(0.75)

Industry Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	14	7	6	0	2	0	1.80	0.98	0.96	2	1.31
Validating	10	8	5	4	1	1	2.05	1.15	1.31	2	0.93
Program Est	12	11	4	2	0	0	1.47	0.70	0.48	1	0.89
Budgeting	2	17	6	3	1	0	1.56	0.83	0.69	1	1.08
ICE	5	10	7	6	1	0	1.92	0.91	0.83	2	0.26
Software	7	13	4	3	1	1	1.77	1.13	1.27	1	1.24
Repair Parts	9	3	5	8	4	0	2.65	0.96	0.93	3	(0.03)
R&D	7	7	9	4	2	0	2.05	0.93	0.86	2	0.32
Service	8	2	4	7	8	0	3.00	0.98	0.95	3	(0.30)
Hardware	8	9	5	4	3	0	2.05	1.09	1.19	2	0.58
Construction	5	7	7	6	4	0	2.29	1.06	1.12	2	0.10
Commodity	13	1	1	5	9	0	3.38	0.86	0.73	4	0.07
Question 2											
CE	1	13	10	4	1	0	1.75	0.83	0.69	2	0.68
PD&RR	1	13	10	3	2	0	1.79	0.90	0.81	2	0.87
E&MD	2	10	9	8	0	0	1.93	0.81	0.66	2	(0.11)
PFD&OS	4	8	5	9	3	0	2.28	1.03	1.06	2	(0.02)
Question 3											
FFP	7	9	6	5	1	1	2.05	1.11	1.23	2	0.72
FPE	11	8	5	3	1	1	2.00	1.15	1.33	2	1.10
FPIS	10	8	5	5	1	0	1.95	0.94	0.89	2	0.56
FPR(P)	10	8	6	4	1	0	1.89	0.91	0.89	2	0.60
FPR(R)	10	9	5	4	1	0	1.84	0.93	0.87	2	0.70
FPIF	9	9	5	5	1	0	1.90	0.94	0.89	2	0.55
CPIF	9	12	3	2	3	0	1.89	1.12	1.26	1	1.08
CPAF	9	12	3	2	3	0	1.89	1.12	1.26	1	1.08
CPFF	9	13	3	2	2	0	1.65	1.01	1.03	1	1.20
T&M	8	4	4	5	4	3	2.90	1.44	2.09	3	0.29
Labor Hour	11	2	4	5	4	3	3.11	1.24	1.54	3	0.30
Question 4											
Pre-Award	3	13	7	6	0	0	1.73	0.81	0.66	2	0.25
Post-Award	5	9	5	5	4	1	2.29	1.24	1.54	2	0.42

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	0	14	7	8	0	0	1.79	0.85	0.72	2	0.43
5b	10	7	8	3	1	0	1.89	0.85	0.73	2	0.54
5c	0	16	9	4	0	0	1.59	0.72	0.52	1	0.85
5d	0	14	11	2	0	2	1.79	1.06	1.13	2	1.90
5e	11	3	7	5	3	0	2.44	0.96	0.91	2	0.32
5f	9	7	10	2	1	0	1.85	0.79	0.63	2	0.45
Question 6											
6a	3	7	11	5	3	0	2.15	0.95	0.90	2	0.14
6b	2	4	2	16	5	0	2.81	0.90	0.82	3	(1.00)
6c	12	5	8	3	1	0	2.00	0.84	0.71	2	0.58
6d	0	5	7	13	4	0	2.55	0.93	0.87	3	(0.29)
6e	1	4	11	9	4	0	2.46	0.91	0.82	2	(0.20)
6f	3	5	13	6	2	0	2.19	0.83	0.69	2	(0.13)
6g	12	1	7	6	3	0	2.65	0.84	0.70	3	0.21
Question 7											
7a	3	9	8	6	3	0	2.12	1.01	1.03	2	0.21
7c	2	13	10	3	1	0	1.70	0.81	0.65	2	0.65
7c	3	13	11	1	1	0	1.62	0.74	0.54	2	0.70
Question 8											
8a	4	4	12	4	5	0	2.40	0.98	0.96	2	(0.02)
8b	5	4	15	2	3	0	2.17	0.85	0.72	2	0.13
8c	4	6	14	4	1	0	2.00	0.75	0.56	2	(0.09)
8d	16	1	8	3	1	0	2.31	0.72	0.52	2	0.72
Question 9											
9	7	2	8	8	3	1	2.68	0.97	0.94	3	(0.06)
Question 10											
10a	1	4	12	8	2	2	2.50	1.05	1.11	2	0.45
10b	10	0	7	11	1	0	2.68	0.57	0.32	3	(0.32)
10c	2	3	9	12	3	0	2.56	0.83	0.69	3	(0.65)
10d	2	3	12	8	4	0	2.48	0.88	0.77	2	(0.31)

U.S. Army Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	20	1	10	17	3	0	2.71	0.68	0.46	3	(0.06)
Validating	16	2	6	21	6	0	2.89	0.75	0.56	3	(0.34)
Program Est	13	4	16	17	1	0	2.39	0.71	0.50	2	(0.39)
Budgeting	14	3	14	18	2	0	2.51	0.72	0.52	3	(0.35)
ICE	18	3	13	15	2	0	2.48	0.74	0.55	3	(0.06)
Software	18	5	8	13	7	0	2.67	0.97	0.95	3	0.09
Repair Parts	14	1	6	24	6	0	2.95	0.66	0.43	3	(0.58)
R&D	13	5	8	16	8	1	2.79	1.00	1.01	3	(0.17)
Service	10	3	9	15	13	1	3.00	0.96	0.93	3	(0.49)
Hardware	9	2	10	25	5	0	2.79	0.71	0.50	3	(0.84)
Construction	17	1	13	13	7	0	2.76	0.81	0.65	3	(0.11)
Commodity	24	0	4	18	5	0	3.04	0.58	0.33	3	0.09
Question 2											
CE	11	7	11	15	5	2	2.60	1.07	1.14	3	0.01
PD&RR	11	3	17	18	2	0	2.48	0.71	0.50	3	(0.52)
E&MD	10	2	15	21	3	0	2.61	0.69	0.48	3	(0.67)
PFD&OS	10	3	11	17	10	0	2.83	0.88	0.78	3	(0.52)
Question 3											
FFP	13	4	9	15	9	1	2.84	0.99	0.98	3	(0.21)
FPE	17	2	7	14	9	1	3.00	0.92	0.85	3	(0.05)
FPIS	19	1	6	20	5	0	2.91	0.68	0.46	3	(0.19)
FPR(P)	18	1	6	21	5	0	2.91	0.67	0.85	3	(0.27)
FPR(R)	18	1	6	19	7	0	2.97	0.72	0.51	3	(0.24)
FPIF	18	1	9	16	6	0	2.84	0.75	0.57	3	(0.09)
CPIF	17	2	8	16	6	0	2.88	0.83	0.85	3	(0.17)
CPAF	18	1	12	13	6	0	2.82	0.92	0.57	3	(0.12)
CPFF	18	3	10	14	6	0	2.70	0.87	0.76	3	(0.00)
T&M	16	1	6	17	9	2	3.14	0.87	0.75	3	(0.23)
Labor Hour	17	1	7	12	12	2	3.21	0.93	0.87	3	(0.15)
Question 4											
Pre-Award	8	4	10	26	3	0	2.65	0.74	0.55	3	(0.84)
Post-Award	10	2	5	18	15	1	3.20	0.86	0.74	3	(0.73)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	7	3	16	15	10	0	2.73	0.89	0.79	3	(0.52)
5b	8	2	19	15	7	0	2.63	0.81	0.65	3	(0.50)
5c	6	6	26	7	6	0	2.29	0.86	0.74	2	(0.04)
5d	7	4	27	9	4	0	2.30	0.76	0.57	2	(0.27)
5e	10	2	8	17	14	0	3.05	0.85	0.73	3	(0.68)
5f	8	2	24	13	4	0	2.44	0.73	0.53	2	(0.47)
Question 6											
6a	10	8	19	8	6	0	2.29	0.94	0.89	2	0.06
6b	8	6	15	13	9	0	2.58	0.97	0.94	3	(0.28)
6c	6	3	23	12	7	0	2.51	0.83	0.69	2	(0.36)
6d	6	3	25	13	4	0	2.40	0.74	0.55	2	(0.46)
6e	7	7	21	14	2	0	2.25	0.77	0.60	2	(0.39)
6f	9	11	24	4	3	0	1.98	0.80	0.64	2	0.18
6g	9	5	18	16	3	0	2.40	0.79	0.62	2	(0.42)
Question 7											
7a	6	16	25	3	1	0	1.76	0.67	0.45	2	0.04
7b	6	16	24	4	1	0	1.78	0.70	0.48	2	0.06
7c	6	17	27	0	1	0	1.67	0.60	0.36	2	(0.03)
Question 8											
8a	7	6	30	6	2	0	2.09	0.67	0.45	2	(0.30)
8b	6	6	30	8	1	0	2.09	0.63	0.39	2	(0.53)
8c	7	8	32	2	2	0	1.95	0.64	0.41	2	(0.16)
8d	11	5	30	4	1	0	2.03	0.57	0.32	2	(0.39)
Question 9											
9	18	3	12	13	5	0	2.61	0.85	0.72	3	0.03
Question 10											
10a	7	1	17	23	3	0	2.64	0.64	0.41	3	(0.96)
10b	11	0	10	23	7	0	2.93	0.65	0.42	3	(0.77)
10c	8	2	14	20	7	0	2.74	0.78	0.61	3	(0.70)
10d	10	7	13	16	5	0	2.46	0.91	0.83	3	(0.25)

DCMC Group Data

	No Response	# 1	# 2	# 3	# 4	# 5		Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	12	0	8	9	5	1	2.96	0.86	0.74	3	(0.04)
Validating	11	1	9	11	3	0	2.67	0.75	0.56	3	(0.22)
Program Est	10	3	13	9	0	0	2.24	0.65	0.42	2	(0.31)
Budgeting	9	6	12	8	0	0	2.08	0.73	0.53	2	(0.18)
ICE	18	5	4	5	3	0	2.35	1.08	1.17	2	0.85
Software	13	3	7	8	4	0	2.59	0.94	0.88	3	0.17
Repair Parts	10	1	7	13	4	0	2.80	0.75	0.56	3	(0.38)
R&D	10	1	10	6	7	1	2.88	0.99	0.99	3	(0.05)
Service	12	1	4	10	8	0	3.09	0.83	0.69	3	(0.22)
Hardware	11	2	12	9	1	0	2.38	0.70	0.48	2	(0.17)
Construction	18	1	7	4	5	0	2.76	0.94	0.89	3	0.59
Commodity	20	0	3	5	7	0	3.27	0.77	0.60	3	0.55
Question 2											
CE	12	5	6	5	7	0	2.61	1.11	1.23	3	0.25
PD&RR	10	4	9	6	5	1	2.60	1.10	1.20	2	0.20
E&MD	10	3	13	7	2	0	2.32	0.75	0.56	2	(0.13)
PFD&OS	9	3	1	1	0	0	1.60	0.84	0.71	3	(0.20)
Question 3											
FFP	8	12	15	8	2	0	2.00	0.86	0.74	2	0.01
FPE	16	10	7	10	2	0	2.14	0.88	0.78	3	0.41
FPIS	17	9	8	11	0	0	2.07	0.68	0.46	3	0.30
FPR(P)	14	6	11	9	0	0	2.12	0.70	0.49	2	0.08
FPR(R)	15	6	8	10	1	0	2.24	0.80	0.64	3	0.25
FPIF	13	6	9	11	1	0	2.26	0.78	0.61	3	0.05
CPIF	10	7	8	12	3	0	2.37	0.90	0.81	3	(0.11)
CPAF	13	7	4	14	2	0	2.41	0.89	0.79	3	0.03
CPFF	11	7	6	14	2	0	2.38	0.87	0.75	3	(0.12)
T&M	12	3	9	9	5	2	2.79	1.08	1.17	3	0.13
Labor Hour	12	3	11	7	5	2	2.71	1.12	1.24	3	0.23
Question 4											
Pre-Award	8	5	12	7	3	0	2.30	0.90	0.80	2	(0.01)
Post-Award	9	4	6	11	4	1	2.69	1.03	1.06	3	(0.06)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5		Std Dev	Variation	Median	Skew
5a	9	3	11	9	3	0	2.46	0.84	0.71	2	(0.16)
5b	10	2	14	7	2	0	2.36	0.74	0.55	2	(0.12)
5c	7	8	14	5	1	0	1.96	0.78	0.61	2	0.03
5d	7	3	17	7	1	0	2.21	0.67	0.45	2	(0.39)
5e	14	0	7	10	4	0	2.86	0.71	0.50	3	(0.01)
5f	9	2	16	6	2	0	2.31	0.72	0.52	2	(0.16)
Question 6											
6a	11	2	17	5	0	0	2.13	0.53	0.28	2	(0.31)
6b	11	1	9	10	4	0	2.71	0.79	0.62	3	(0.18)
6c	10	2	15	8	0	0	2.24	0.59	0.34	2	(0.39)
6d	9	3	13	8	2	0	2.35	0.78	0.61	2	(0.16)
6e	9	3	12	8	3	0	2.42	0.84	0.71	2	(0.12)
6f	10	4	14	6	1	0	2.16	0.73	0.53	2	(0.05)
6g	12	3	10	8	2	0	2.39	0.82	0.67	2	0.07
Question 7											
7a	6	12	15	1	1	0	1.69	0.70	0.49	2	0.31
7b	6	8	17	4	0	0	1.86	0.63	0.39	2	(0.37)
7c	7	[illegible]	16	3	0	0	1.79	0.62	0.38	2	(0.26)
Question 8											
8a	7	2	18	5	3	0	2.32	0.76	0.58	2	(0.18)
8b	8	4	17	3	3	0	2.19	0.82	0.67	2	0.09
8c	7	9	15	3	1	0	1.86	0.74	0.55	2	0.13
8d	9	5	15	4	2	0	2.12	0.80	0.64	2	0.11
Question 9											
9	10	2	12	7	4	0	2.52	0.85	0.73	2	(0.06)
Question 10											
10a	8	2	12	10	3	0	2.52	0.79	0.62	2	(0.33)
10b	13	0	7	12	3	0	2.82	0.65	0.42	3	(0.16)
10c	6	1	15	12	1	0	2.45	0.62	0.39	2	(0.77)
10d	7	4	11	11	2	0	2.39	0.82	0.67	2	(0.34)

DCAA Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	14	1	8	17	7	0	2.91	0.75	0.57	3	(0.37)
Validating	9	2	12	17	5	2	2.82	0.91	0.83	3	(0.32)
Program Est	14	1	10	18	4	0	2.76	0.70	0.49	3	(0.37)
Budgeting	17	1	13	12	4	0	2.63	0.75	0.57	3	(0.03)
ICE	34	1	4	4	4	0	2.85	0.95	0.90	3	1.43
Software	22	1	6	9	8	1	3.08	0.93	0.87	3	0.32
Repair Parts	18	1	7	13	8	0	2.97	0.81	0.65	3	(0.05)
R&D	15	0	4	9	17	2	3.53	0.79	0.62	4	(0.41)
Service	16	1	8	8	14	0	3.13	0.91	0.82	3	(0.16)
Hardware	14	2	15	11	5	0	2.58	0.82	0.67	2	(0.11)
Construction	17	1	10	14	5	0	2.77	0.76	0.58	3	(0.08)
Commodity	24	0	3	12	7	1	3.26	0.74	0.54	3	0.32
Question 2											
CE	14	1	9	9	14	0	3.09	0.90	0.81	3	(0.29)
PD&RR	11	1	10	19	6	0	2.83	0.73	0.53	3	(0.58)
E&MD	14	1	9	19	4	0	2.79	0.69	0.47	3	(0.40)
PFD&OS	15	1	13	14	4	0	2.66	0.73	0.54	3	(0.20)
Question 3											
FFP	15	0	14	12	6	0	2.75	0.75	0.56	3	(0.18)
FPE	16	0	12	11	6	0	2.79	0.76	0.58	3	0.01
FPIS	18	0	10	13	6	0	2.86	0.73	0.58	3	(0.05)
FPR(P)	17	0	13	12	5	0	2.73	0.73	0.58	3	(0.07)
FPR(R)	16	0	11	14	6	0	2.84	0.72	0.52	3	(0.19)
FPIF	15	0	13	14	5	0	2.75	0.71	0.60	3	(0.24)
CPIF	18	0	9	18	6	0	2.91	0.67	0.45	3	(0.43)
CPAF	16	1	9	15	7	0	2.90	0.78	0.60	3	(0.19)
CPFF	15	1	8	17	6	0	2.88	0.74	0.55	3	(0.30)
T&M	15	0	5	11	16	0	3.34	0.73	0.54	4	(0.43)
Labor Hour	16	0	4	13	14	0	3.32	0.69	0.48	3	(0.37)
Question 4											
Pre-Award	10	1	17	17	2	0	2.54	0.64	0.41	3	(0.63)
Post-Award	11	0	1	12	18	5	3.75	0.72	0.52	4	(0.83)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	7	6	9	19	6	0	2.63	0.91	0.83	3	(0.53)
5b	6	5	22	11	3	0	2.29	0.77	0.60	2	(0.34)
5c	7	4	27	8	1	0	2.15	0.61	0.38	2	(0.56)
5d	7	3	22	13	2	0	2.35	0.69	0.48	2	(0.57)
5e	11	0	9	20	7	0	2.94	0.66	0.44	3	(0.68)
5f	7	4	23	9	4	0	2.33	0.79	0.62	2	(0.25)
Question 6											
6a	6	4	25	10	2	0	2.24	0.69	0.48	2	(0.46)
6b	9	2	13	20	3	0	2.63	0.70	0.50	3	(0.70)
6c	9	3	17	10	8	0	2.61	0.90	0.82	2	(0.26)
6d	11	6	22	8	0	0	2.06	0.62	0.39	2	(0.39)
6e	11	6	17	11	2	0	2.25	0.79	0.63	2	(0.16)
6f	8	12	20	6	1	0	1.90	0.74	0.55	2	(0.01)
6g	13	1	14	15	4	0	2.65	0.72	0.52	3	(0.34)
Question 7											
7a	5	20	19	2	1	0	1.62	0.69	0.47	2	0.42
7b	5	15	25	1	1	0	1.71	0.63	0.39	2	0.02
7b	5	20	21	0	1	0	1.57	0.62	0.39	2	0.34
Question 8											
8a	7	12	14	9	5	0	2.18	1.00	0.99	2	0.15
8b	7	14	11	9	6	0	2.18	1.07	1.14	2	0.22
8c	5	16	22	3	1	0	1.74	0.69	0.48	2	0.15
8d	5	12	21	8	1	0	1.95	0.75	0.57	2	(0.10)
Question 9											
9	15	5	17	8	1	1	2.25	0.87	0.75	2	0.31
Question 10											
10a	7	2	23	12	3	0	2.40	0.70	0.49	2	(0.52)
10b	12	0	10	22	2	1	2.83	0.65	0.43	3	(0.52)
10c	9	2	17	15	3	1	2.58	0.82	0.66	3	(0.30)
10d	9	0	15	20	2	1	2.71	0.68	0.47	3	(0.59)

NASA Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	3	3	1	2	0	0	1.83	0.90	0.81	2	0.57
Validating	1	2	3	3	0	0	2.13	0.78	0.61	2	(0.55)
Program Est	2	5	1	0	1	0	1.57	1.05	1.10	1	1.68
Budgeting	0	4	3	2	0	0	1.78	0.79	0.62	2	0.50
ICE	3	3	2	1	0	0	1.67	0.75	0.56	2	0.55
Software	3	2	2	1	1	0	2.17	1.07	1.14	2	0.64
Repair Parts	3	1	2	2	1	0	2.50	0.96	0.92	3	0.16
R&D	2	3	1	1	1	0	2.00	1.12	1.27	2	0.42
Service	1	1	2	3	2	0	2.75	0.97	0.94	3	(0.66)
Hardware	1	3	2	2	0	0	1.86	1.05	1.11	2	0.26
Construction	2	1	2	4	0	0	2.43	0.88	0.78	3	(0.56)
Commodity	3	1	1	1	3	0	3.00	1.15	1.33	4	0.00
Question 2											
CE	1	6	1	0	1	0	1.50	1.00	1.00	1	1.92
PD&RR	2	5	1	0	1	0	1.57	1.05	1.10	1	1.68
E&MD	0	1	4	4	0	0	2.33	0.67	0.44	2	(0.61)
PFD&OS	1	0	2	5	1	0	2.88	0.60	0.36	3	(1.51)
Question 3											
FFP	5	1	2	1	0	0	2.00	0.71	0.50	2	0.87
FPE	6	1	2	0	0	0	1.67	0.47	0.22	2	1.19
FPIS	6	1	2	1	0	0	2.00	0.71	0.50	2	0.87
FPR(P)	5	1	2	0	0	0	1.67	0.47	0.22	2	1.19
FPR(R)	6	1	2	0	0	0	1.67	0.47	0.22	2	1.19
FPIF	5	1	2	1	0	0	2.00	0.71	0.50	2	0.87
CPIF	5	1	2	0	1	0	2.25	1.09	1.19	2	1.36
CPAF	6	1	2	0	1	0	2.25	1.09	1.19	2	1.36
CPFF	5	1	2	0	1	0	2.25	1.09	1.19	2	1.36
T&M	6	0	1	1	1	0	3.00	0.82	0.67	3	1.22
Labor Hour	6	0	1	1	1	0	3.00	0.82	0.67	3	1.22
Question 4											
Pre-Award	1	4	1	2	0	0	1.71	0.93	0.86	2	0.15
Post-Award	2	3	1	1	2	0	2.29	1.28	1.63	2	0.47

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	1	1	3	3	1	0	2.50	0.87	0.75	3	(0.54)
5b	2	1	4	2	0	0	2.14	0.64	0.41	2	(0.54)
5c	1	5	2	1	0	0	1.50	0.71	0.50	1	0.66
5d	1	5	2	1	0	0	1.50	0.71	0.50	1	0.66
5e	2	1	3	2	1	0	2.43	0.90	0.82	2	(0.13)
5f	2	0	6	1	0	0	2.14	0.35	0.12	2	(1.07)
Question 6											
6a	1	3	4	1	0	0	1.75	0.66	0.44	2	(0.21)
6b	0	1	1	6	0	0	2.63	0.70	0.48	3	(1.53)
6c	4	1	4	0	0	0	1.80	0.40	0.16	2	0.00
6d	1	2	3	2	1	0	2.25	0.97	0.94	2	0.00
6e	1	0	3	3	1	0	2.71	0.78	0.61	3	(0.93)
6f	1	3	3	2	0	0	1.88	0.78	0.61	2	(0.11)
6g	2	0	2	4	1	0	2.86	0.64	0.41	3	(0.86)
Question 7											
7a	1	4	2	1	1	0	1.88	1.05	1.11	2	0.82
7b	1	3	4	0	0	0	1.57	0.50	0.25	2	(0.61)
7c	1	3	4	1	0	0	1.75	0.66	0.44	2	(0.21)
Question 8											
8a	2	0	4	3	0	0	2.43	0.49	0.24	2	(0.95)
8b	2	0	3	4	0	0	2.57	0.49	0.24	3	(1.05)
8c	2	1	4	2	0	0	2.14	0.64	0.41	2	(0.54)
8d	3	1	4	1	0	0	2.00	0.58	0.33	2	(0.15)
Question 9											
9	2	1	6	0	0	0	1.86	0.35	0.12	2	(1.19)
Question 10											
10a	1	0	3	2	3	0	3.00	0.87	0.75	3	(0.88)
10b	2	0	2	3	2	0	3.00	0.76	0.57	3	(0.73)
10c	1	1	2	3	2	0	2.75	0.97	0.94	3	(0.66)
10d	1	1	3	3	1	0	2.50	0.87	0.75	3	(0.54)

U.S. Navy Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	10	0	6	5	1	0	2.58	0.64	0.41	3	0.20
Validating	3	1	9	8	1	0	2.47	0.68	0.46	2	(0.79)
Program Est	3	3	9	7	0	0	2.21	0.69	0.48	2	(0.69)
Budgeting	3	3	12	3	1	0	2.11	0.72	0.52	2	(0.22)
ICE	8	2	5	4	3	0	2.57	0.98	0.96	3	0.23
Software	7	1	5	6	3	0	2.73	0.85	0.73	3	(0.12)
Repair Parts	7	0	5	5	5	0	3.00	0.82	0.67	3	(0.24)
R&D	5	1	3	11	2	0	2.82	0.71	0.50	3	(0.73)
Service	6	0	2	8	6	0	3.25	0.66	0.44	3	(0.66)
Hardware	2	1	9	8	2	0	2.55	0.74	0.55	3	(0.72)
Construction	12	0	1	8	1	0	3.00	0.45	0.20	3	0.32
Commodity	12	0	1	6	3	0	3.20	0.60	0.36	3	0.38
Question 2											
CE	1	5	3	9	4	0	2.57	1.05	1.10	3	(0.45)
PD&RR	1	2	8	9	2	0	2.52	0.79	0.63	3	(0.61)
E&MD	0	3	6	11	2	0	2.55	0.84	0.70	3	(0.40)
PFD&OS	1	1	7	7	6	0	2.86	0.89	0.79	3	(0.65)
Question 3											
FFP	4	0	7	8	3	0	2.78	0.71	0.51	3	(0.71)
FPE	8	0	6	5	3	0	2.79	0.77	0.60	3	(0.03)
FPIS	9	1	5	6	1	0	2.54	0.75	0.56	3	0.11
FPR(P)	8	1	5	7	1	0	2.57	0.73	0.53	3	(0.08)
FPR(R)	9	1	6	5	1	0	2.46	0.75	0.56	2	0.17
FPIF	5	0	7	8	2	0	2.71	0.67	0.44	3	(0.61)
CPIF	6	2	6	6	2	0	2.50	0.67	0.75	3	(0.13)
CPAF	5	2	6	8	1	0	2.47	0.78	0.60	3	(0.43)
CPFF	4	2	6	8	2	0	2.56	0.83	0.69	3	(0.49)
T&M	9	0	1	9	3	0	3.15	0.53	0.28	3	(0.19)
Labor Hour	8	0	3	7	4	0	3.07	0.70	0.49	3	(0.22)
Question 4											
Pre-Award	2	3	9	5	3	0	2.40	0.92	0.84	2	(0.18)
Post-Award	3	1	5	6	7	0	3.00	0.92	0.84	3	(0.76)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	1	2	9	9	1	0	2.43	0.73	0.53	2	(0.71)
5b	1	2	8	10	1	0	2.48	0.73	0.54	3	(0.83)
5c	0	2	13	7	0	0	2.23	0.60	0.36	2	(0.14)
5d	1	2	13	3	3	0	2.33	0.84	0.70	2	0.18
5e	3	1	4	8	6	0	3.00	0.86	0.74	3	(0.88)
5f	4	1	10	6	1	0	2.39	0.68	0.46	2	(0.55)
Question 6											
6a	2	1	12	5	2	0	2.40	0.73	0.54	2	(0.40)
6b	1	0	7	12	2	0	2.76	0.61	0.37	3	(1.25)
6c	2	2	13	3	2	0	2.25	0.77	0.59	2	(0.10)
6d	1	5	7	6	3	0	2.33	0.99	0.98	2	(0.03)
6e	1	5	8	5	3	0	2.29	0.98	0.97	2	0.08
6f	4	1	14	1	2	0	2.22	0.71	0.51	2	(0.08)
6g	3	1	8	5	5	0	2.74	0.91	0.83	3	(0.47)
Question 7											
7a	2	4	12	4	0	0	2.00	0.63	0.40	2	(0.64)
7c	1	5	16	0	0	0	1.76	0.43	0.18	2	(1.67)
7c	1	7	14	0	0	0	1.67	0.47	0.22	2	(1.15)
Question 8											
8a	6	3	7	5	1	0	2.25	0.83	0.69	2	(0.02)
8b	6	2	10	1	3	0	2.31	0.92	0.84	2	0.24
8c	5	4	10	1	2	0	2.06	0.87	0.76	2	0.33
8d	6	2	11	2	1	0	2.13	0.70	0.48	2	(0.02)
Question 9											
9	8	2	10	2	0	0	2.00	0.53	0.29	2	(0.10)
Question 10											
10a	3	1	7	6	5	0	2.79	0.89	0.80	3	(0.57)
10b	4	1	6	9	2	0	2.67	0.75	0.56	3	(0.69)
10c	5	0	6	8	3	0	2.82	0.71	0.50	3	(0.61)
10d	5	3	6	6	2	0	2.41	0.91	0.83	2	(0.14)

USAF Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	5	2	5	5	0	0	2.25	0.72	0.52	2	(0.23)
Validating	1	1	7	7	1	0	2.50	0.71	0.50	3	(0.83)
Program Est	1	5	8	3	0	0	1.88	0.70	0.48	2	(0.24)
Budgeting	1	5	6	4	1	0	2.06	0.90	0.81	2	0.13
ICE	3	3	7	4	0	0	2.07	0.70	0.49	2	(0.44)
Software	3	2	9	3	0	0	2.07	0.59	0.35	2	(0.66)
Repair Parts	5	1	1	8	2	0	2.92	0.76	0.58	3	(0.47)
R&D	3	2	9	1	2	0	2.21	0.86	0.74	2	0.13
Service	3	1	1	7	5	0	3.14	0.83	0.69	3	(0.95)
Hardware	2	1	5	8	1	0	2.60	0.71	0.51	3	(0.98)
Construction	7	1	4	3	2	0	2.60	0.92	0.84	3	0.31
Commodity	6	1	0	3	7	0	3.45	0.89	0.79	4	(0.32)
Question 2											
CE	2	4	9	1	1	0	1.93	0.77	0.60	2	0.23
PD&RR	2	5	6	2	2	0	2.07	1.00	1.00	2	0.38
E&MD	2	4	8	2	1	0	2.00	0.82	0.67	2	0.15
PFD&OS	1	4	5	6	1	0	2.25	0.85	0.72	2	(0.48)
Question 3											
FFP	0	1	4	11	1	0	2.71	0.67	0.44	3	(0.86)
FPE	3	0	3	9	2	0	2.93	0.59	0.35	3	(1.10)
FPIS	3	0	7	5	2	0	2.64	0.72	0.52	3	(0.60)
FPR(P)	3	0	7	5	2	0	2.64	0.72	0.52	3	(0.60)
FPR(R)	3	0	7	5	2	0	2.64	0.72	0.52	3	(0.60)
FPIF	3	0	9	3	2	0	2.50	0.73	0.54	2	(0.37)
CPIF	4	2	6	3	2	0	2.38	0.92	0.85	2	0.00
CPAF	2	4	7	2	2	0	2.13	0.96	0.92	2	0.25
CPFF	2	4	7	1	3	0	2.20	1.05	1.09	2	0.34
T&M	2	1	3	2	9	0	3.27	1.00	1.00	4	(1.02)
Labor Hour	2	1	3	3	8	0	3.20	0.98	0.96	4	(0.97)
Question 4											
Pre-Award	0	4	5	7	1	0	2.29	0.89	0.80	2	(0.12)
Post-Award	1	2	6	4	4	0	2.63	0.96	0.91	3	(0.37)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	0	4	4	5	4	0	2.53	1.09	1.19	3	(0.08)
5b	0	2	7	7	1	0	2.41	0.77	0.60	2	(0.10)
5c	0	6	6	5	0	0	1.94	0.80	0.64	2	0.12
5d	0	6	10	1	0	0	1.71	0.57	0.33	2	0.11
5e	1	1	3	9	3	0	2.88	0.78	0.61	3	(1.18)
5f	1	3	10	2	1	0	2.06	0.75	0.56	2	0.13
Question 6											
6a	1	4	10	2	0	0	1.88	0.60	0.36	2	(0.56)
6b	1	0	2	9	5	0	3.19	0.63	0.40	3	(1.70)
6c	0	5	9	3	0	0	1.88	0.68	0.46	2	0.16
6d	2	1	7	6	1	0	2.47	0.72	0.52	2	(0.74)
6e	2	1	7	5	2	0	2.53	0.81	0.65	2	(0.52)
6f	0	1	12	3	1	0	2.24	0.64	0.42	2	1.16
6g	2	1	5	6	3	0	2.73	0.85	0.73	3	(0.69)
Question 7											
7a	0	3	13	1	0	0	1.88	0.47	0.22	2	(0.40)
7b	0	5	11	1	0	0	1.76	0.55	0.30	2	(0.08)
7c	0	5	12	0	0	0	1.71	0.46	0.21	2	(0.99)
Question 8											
8a	2	4	6	2	3	0	2.27	1.06	1.13	2	0.21
8b	2	3	8	4	0	0	2.07	0.68	0.46	2	(0.60)
8c	1	7	6	2	1	0	1.81	0.88	0.78	2	0.68
8d	1	4	8	1	3	0	2.19	1.01	1.03	2	0.44
Question 9											
9	1	0	11	4	1	0	2.38	0.58	0.33	2	(0.47)
Question 10											
10a	0	3	3	8	3	0	2.65	0.97	0.93	3	(0.46)
10b	1	0	6	6	3	1	2.94	0.90	0.81	3	(0.32)
10c	1	0	3	9	4	0	3.06	0.66	0.43	3	(1.48)
10d	1	4	6	5	1	0	2.19	0.88	0.78	2	(0.13)

Cost Estimating Community Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	10	6	10	8	6	0	2.47	1.02	1.05	2	0.05
Validating	2	5	12	17	3	1	2.55	0.91	0.83	3	(0.27)
Program Est	5	8	10	16	1	0	2.29	0.85	0.72	2	(0.47)
Budgeting	4	8	13	13	2	0	2.25	0.86	0.74	2	(0.31)
ICE	15	4	9	8	4	0	2.48	0.94	0.89	2	0.25
Software	10	6	6	11	6	1	2.67	1.11	1.22	3	0.00
Repair Parts	11	2	4	16	7	0	2.97	0.81	0.65	3	(0.46)
R&D	10	2	11	9	8	0	2.77	0.92	0.85	3	(0.24)
Service	11	1	4	14	10	0	3.14	0.78	0.60	3	(0.52)
Hardware	9	1	10	16	4	0	2.74	0.72	0.51	3	(0.59)
Construction	8	4	10	14	4	0	2.56	0.86	0.75	3	(0.39)
Commodity	17	1	2	13	7	0	3.13	0.74	0.55	3	(0.02)
Question 2											
CE	3	10	12	6	9	0	2.38	1.11	1.22	2	0.07
PD&RR	3	7	14	9	7	0	2.43	1.00	1.00	2	(0.11)
E&MD	5	4	12	16	3	1	2.58	0.78	0.61	3	(0.70)
PFD&OS	6	2	10	20	2	0	2.65	0.68	0.46	3	(0.93)
Question 3											
FFP	14	5	9	14	3	0	2.48	0.78	0.61	3	(0.09)
FPE	19	4	7	11	4	0	2.58	0.79	0.63	3	0.30
FPIS	19	4	9	11	2	0	2.42	0.72	0.52	3	0.29
FPR(P)	20	4	9	10	2	0	2.40	0.79	0.54	3	0.40
FPR(R)	19	4	8	11	3	0	2.50	0.76	0.59	3	0.30
FPIF	17	4	8	12	4	0	2.57	0.79	0.63	3	0.12
CPIF	17	5	8	10	5	0	2.54	0.90	0.80	3	0.29
CPAF	17	5	8	11	4	0	2.50	0.96	0.73	3	0.21
CPFF	17	5	8	11	4	0	2.50	0.86	0.73	3	0.21
T&M	16	5	6	11	7	0	2.69	0.91	0.83	3	0.08
Labor Hour	17	3	8	11	6	0	2.71	0.75	0.56	3	0.08
Question 4											
Pre-Award	5	9	13	15	3	1	2.37	0.87	0.75	2	(0.42)
Post-Award	5	6	7	14	12	2	2.93	1.00	1.00	3	(0.66)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	5	10	8	18	4	1	2.46	0.94	0.88	3	(0.44)
5b	3	8	17	14	4	0	2.33	0.85	0.73	2	(0.34)
5c	5	13	17	10	0	1	2.00	0.76	0.57	2	(0.32)
5d	3	13	20	8	2	0	1.98	0.82	0.67	2	0.08
5e	8	6	11	11	9	0	2.62	0.97	0.94	3	(0.32)
5f	3	9	21	8	5	0	2.21	0.89	0.79	2	0.07
Question 6											
6a	9	9	20	5	2	0	2.00	0.78	0.60	2	0.01
6b	5	8	10	17	5	1	2.54	0.90	0.82	3	(0.51)
6c	6	2	19	11	2	0	2.38	0.69	0.47	2	(0.57)
6d	4	7	16	10	4	0	2.30	0.86	0.74	2	(0.18)
6e	4	6	19	9	3	0	2.24	0.78	0.60	2	(0.27)
6f	9	5	22	4	0	0	1.97	0.54	0.29	2	(0.53)
6g	9	1	13	13	4	0	2.65	0.74	0.55	3	(0.47)
Question 7											
7a	4	14	15	6	2	0	1.89	0.80	0.64	2	0.21
7b	4	13	20	2	2	0	1.81	0.68	0.47	2	0.16
7c	5	16	17	1	1	1	1.72	0.68	0.46	2	0.38
Question 8											
8a	9	5	15	7	4	0	2.32	0.89	0.80	2	(0.00)
8b	9	6	16	4	5	0	2.26	0.95	0.90	2	0.19
8c	9	11	15	2	3	0	1.90	0.89	0.80	2	0.51
8d	11	6	16	6	1	0	2.07	0.74	0.55	2	0.00
Question 9											
9	14	2	12	9	3	0	2.50	0.80	0.63	2	0.04
Question 10											
10a	3	2	13	16	7	0	2.74	0.83	0.68	3	(0.70)
10b	9	1	12	15	3	0	2.65	0.70	0.49	3	(0.56)
10c	8	1	12	17	2	0	2.63	0.65	0.42	3	(0.74)
10d	11	3	11	12	3	0	2.52	0.81	0.66	3	(0.20)

Acquisition Community Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	35	3	21	33	7		2.69	0.74	0.55	3	(0.10)
Validating	22	8	26	32	10		2.58	0.88	0.78	3	(0.24)
Program Est	19	12	37	29	2		2.26	0.74	0.54	2	(0.39)
Budgeting	19	14	35	27	5		2.28	0.82	0.67	2	(0.22)
ICE	49	9	20	17	6		2.38	0.91	0.82	2	0.63
Software	37	8	22	19	12		2.57	0.94	0.88	3	0.21
Repair Parts	29	3	16	38	14		2.89	0.76	0.58	3	(0.34)
R&D	22	7	19	23	27		2.92	1.02	1.05	3	(0.29)
Service	24	4	17	27	27		3.03	0.92	0.84	3	(0.39)
Hardware	16	7	34	32	11		2.56	0.82	0.68	3	(0.43)
Construction	43	2	21	27	7		2.68	0.73	0.53	3	0.17
Commodity	51	1	7	23	16		3.15	0.77	0.60	3	0.36
Question 2											
CE	18	13	24	28	16		2.58	1.01	1.02	3	(0.18)
PD&RR	17	8	33	33	10		2.54	0.83	0.68	3	(0.41)
E&MD	15	10	36	32	7		2.42	0.80	0.64	2	(0.42)
PFD&OS	14	10	32	32	11		2.52	0.86	0.74	3	(0.42)
Question 3											
FFP	17	9	32	32	11		2.54	0.85	0.73	3	(0.37)
FPE	33	4	24	26	13		2.72	0.84	0.71	3	(0.04)
FPIS	32	4	22	34	8		2.68	0.76	0.57	3	(0.17)
FPR(P)	28	5	25	35	7		2.61	0.76	0.57	3	(0.27)
FPR(R)	30	6	23	32	9		2.63	0.81	0.66	3	(0.15)
FPIF	29	4	30	28	7		2.55	0.75	0.56	3	(0.19)
CPIF	25	8	22	24	11		2.58	0.86	0.74	3	(0.26)
CPAF	24	10	24	28	13		2.59	0.92	0.85	3	(0.17)
CPFF	21	11	34	33	12		2.51	0.91	0.83	3	(0.27)
T&M	26	3	18	27	26		3.03	0.91	0.83	3	(0.32)
Labor Hour	26	3	29	26	24		2.87	0.92	0.85	3	(0.29)
Question 4											
Pre-Award	7	14	30	34	5		2.36	0.79	0.63	2	(0.48)
Post-Award	10	5	17	27	27		3.00	0.94	0.88	3	(0.73)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	9	11	33	34	13	12	2.83	0.88	0.78	3	(0.46)
5b	10	9	44	32	5	12	2.68	0.74	0.54	2	(0.56)
5c	5	6	56	16	6	8	2.50	0.77	0.59	2	(0.02)
5d	8	8	65	15	4	11	2.47	0.63	0.40	2	(0.43)
5e	12	2	26	38	21	15	3.21	0.78	0.61	3	(0.81)
5f	11	7	52	24	6	14	2.69	0.72	0.51	2	(0.45)
Question 6											
6a	9	11	55	20	5	12	2.53	0.72	0.52	2	(0.34)
6b	13	5	27	43	12	16	3.07	0.77	0.60	3	(0.74)
6c	8	10	47	23	11	11	2.67	0.83	0.69	2	(0.25)
6d	12	10	52	26	4	15	2.64	0.72	0.52	2	(0.47)
6e	13	11	42	27	6	16	2.75	0.78	0.61	2	(0.37)
6f	11	17	55	12	5	12	2.41	0.74	0.55	2	(0.09)
6g	14	5	39	32	10	17	2.95	0.77	0.60	2	(0.52)
Question 7											
7a	7	28	54	9	2	10	2.15	0.68	0.46	2	(0.06)
7b	6	27	57	8	1	8	2.10	0.62	0.38	2	(0.28)
7c	7	30	59	3	1	10	2.05	0.57	0.33	2	(0.35)
Question 8											
8a	10	16	52	16	5	13	2.48	0.76	0.58	2	(0.19)
8b	10	15	55	15	5	13	2.48	0.74	0.54	2	(0.18)
8c	8	23	51	5	3	11	2.23	0.65	0.42	2	(0.09)
8d	13	15	60	9	2	16	2.45	0.61	0.38	2	(0.38)
Question 9											
9	28	8	43	15	6	31	3.09	0.76	0.58	2	0.02
Question 10											
10a	10	6	43	33	7	14	2.81	0.78	0.61	2	(0.45)
10b	16	0	19	55	8	19	3.27	0.61	0.37	3	(0.94)
10c	10	3	31	45	11	13	3.00	0.72	0.52	3	(0.88)
10d	12	10	36	35	7	15	2.82	0.80	0.63	2	(0.51)

Federal Government Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	66	7	39	55	16	1	2.70	0.81	0.65	3	(0.02)
Validating	43	9	47	67	16	2	2.68	0.81	0.66	3	(0.36)
Program Est	45	21	58	54	6	0	2.32	0.78	0.61	2	(0.25)
Budgeting	46	22	61	47	8	0	2.30	0.80	0.64	2	(0.15)
ICE	86	17	36	33	12	0	2.41	0.91	0.83	2	0.51
Software	68	14	38	40	23	1	2.65	0.96	0.92	3	0.17
Repair Parts	59	5	28	66	26	0	2.90	0.76	0.58	3	(0.28)
R&D	50	12	35	45	37	5	2.91	1.02	1.04	3	(0.14)
Service	50	7	27	51	48	1	3.07	0.89	0.79	3	(0.38)
Hardware	41	11	53	64	15	0	2.58	0.78	0.61	3	(0.42)
Construction	75	5	37	46	21	0	2.76	0.81	0.66	3	0.11
Commodity	91	2	12	45	33	1	3.20	0.76	0.57	3	0.25
Question 2											
CE	43	28	39	39	33	2	2.59	1.09	1.18	3	0.00
PD&RR	39	20	51	55	18	1	2.51	0.90	0.82	3	(0.21)
E&MD	38	14	56	64	12	0	2.51	0.77	0.60	3	(0.45)
PFD&OS	39	13	47	61	24	0	2.66	0.85	0.73	3	(0.40)
Question 3											
FFP	47	12	49	54	21	1	2.64	0.87	0.76	3	(0.21)
FPE	71	6	36	48	22	1	2.79	0.85	0.72	3	0.07
FPIS	73	5	38	54	14	0	2.69	0.74	0.55	3	0.03
FPR(P)	68	6	42	55	13	0	2.65	0.75	0.56	3	(0.04)
FPR(R)	69	6	39	53	17	0	2.70	0.78	0.61	3	(0.01)
FPIF	62	5	49	52	16	0	2.65	0.76	0.57	3	(0.11)
CPIF	58	11	38	55	22	0	2.70	0.86	0.73	3	(0.13)
CPAF	60	13	38	51	21	1	2.67	0.90	0.82	3	(0.02)
CPFF	57	15	38	53	20	1	2.64	0.91	0.83	3	(0.05)
T&M	62	4	22	48	43	5	3.19	0.89	0.79	3	(0.18)
Labor Hour	63	4	26	42	44	5	3.17	0.92	0.85	3	(0.12)
Question 4											
Pre-Award	30	21	56	65	12	0	2.44	0.82	0.68	3	(0.45)
Post-Award	37	12	24	53	51	7	3.12	1.00	1.01	3	(0.48)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	27	19	52	60	26	0	2.59	0.90	0.81	3	(0.43)
5b	29	14	74	52	15	0	2.44	0.79	0.62	2	(0.41)
5c	23	31	89	33	8	0	2.11	0.76	0.58	2	(0.18)
5d	25	23	91	34	11	0	2.21	0.77	0.59	2	(0.22)
5e	43	5	34	66	36	0	2.94	0.80	0.64	3	(0.54)
5f	33	13	89	37	12	0	2.32	0.74	0.55	2	(0.30)
Question 6											
6a	33	22	88	31	10	0	2.19	0.76	0.58	2	(0.18)
6b	33	10	47	71	23	0	2.71	0.80	0.64	3	(0.59)
6c	33	16	81	37	17	0	2.36	0.82	0.67	2	(0.21)
6d	32	20	77	44	11	0	2.30	0.79	0.62	2	(0.29)
6e	33	22	68	47	14	0	2.35	0.84	0.70	2	(0.24)
6f	34	32	87	23	8	0	2.05	0.76	0.58	2	(0.04)
6g	43	11	58	54	18	0	2.56	0.81	0.66	3	(0.31)
Question 7											
7a	22	60	86	12	4	0	1.75	0.69	0.48	2	0.12
7b	21	54	97	10	2	0	1.75	0.62	0.35	2	(0.21)
7c	22	62	94	4	2	0	1.67	0.59	0.35	2	(0.18)
Question 8											
8a	33	27	80	30	14	0	2.21	0.84	0.71	2	(0.04)
8b	33	29	80	29	13	0	2.17	0.84	0.70	2	(0.02)
8c	29	45	89	14	7	0	1.89	0.74	0.55	2	0.10
8d	37	29	89	21	8	0	2.05	0.74	0.55	2	(0.04)
Question 9											
9	56	13	69	34	11	1	2.36	0.81	0.65	2	0.05
Question 10											
10a	29	9	65	61	20	0	2.59	0.78	0.62	3	(0.54)
10b	46	1	41	75	19	2	2.86	0.71	0.50	3	(0.49)
10c	33	6	57	67	20	1	2.69	0.77	0.60	3	(0.55)
10d	36	19	54	61	13	1	2.48	0.85	0.72	3	(0.31)

Prepare Estimates Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	10	8	7	7	5	0	2.33	1.09	1.19	2	0.25
Validating	1	10	12	12	2	0	2.17	0.90	0.81	2	(0.03)
Program Est	2	13	11	10	1	0	1.97	0.88	0.77	2	0.09
Budgeting	2	12	14	8	1	0	1.94	0.83	0.68	2	0.12
ICE	9	9	6	11	2	0	2.21	0.98	0.95	2	0.08
Software	9	10	4	11	3	0	2.25	1.06	1.12	3	0.15
Repair Parts	11	3	6	10	7	0	2.81	0.96	0.92	3	(0.15)
R&D	10	8	6	9	4	0	2.33	1.05	1.11	2	0.18
Service	8	2	4	14	9	0	3.03	0.85	0.72	3	(0.65)
Hardware	7	6	5	15	4	0	2.57	0.96	0.91	3	(0.37)
Construction	11	6	4	12	4	0	2.54	1.01	1.02	3	(0.00)
Commodity	15	2	2	11	7	0	3.05	0.88	0.77	3	0.01
Question 2											
CE	2	17	10	5	3	0	1.83	0.97	0.94	2	0.74
PD&RR	3	14	12	5	3	0	1.91	0.95	0.90	2	0.52
E&MD	3	7	9	17	1	0	2.35	0.84	0.70	3	(0.65)
PFD&OS	5	3	7	16	6	0	2.78	0.84	0.70	3	(0.76)
Question 3											
FFP	10	5	9	9	4	0	2.44	0.96	0.91	2	0.01
FPE	17	5	6	4	5	0	2.45	1.12	1.25	2	0.68
FPIS	17	5	7	6	2	0	2.25	0.94	0.89	2	0.61
FPR(P)	16	5	7	7	2	0	2.29	0.93	0.87	2	0.49
FPR(R)	16	5	7	6	3	0	2.33	0.99	0.98	2	0.55
FPIF	13	7	7	6	4	0	2.29	1.06	1.12	2	0.44
CPIF	13	5	10	5	4	0	2.33	0.99	0.97	2	0.37
CPAF	14	5	10	5	3	0	2.26	0.94	0.89	2	0.43
CPFF	14	5	8	6	4	0	2.39	1.01	1.02	2	0.39
T&M	14	4	5	6	8	0	2.78	1.10	1.21	3	0.22
Labor Hour	14	2	6	8	7	0	2.87	0.95	0.90	3	0.07
Question 4											
Pre-Award	3	9	12	12	1	0	2.15	0.84	0.71	2	(0.28)
Post-Award	4	5	10	12	6	0	2.58	0.94	0.88	3	(0.45)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	4	6	12	12	3	0	2.36	0.88	0.78	2	(0.35)
5b	2	6	15	13	1	0	2.26	0.77	0.59	2	(0.51)
5c	2	13	12	10	0	0	1.91	0.81	0.65	2	(0.07)
5d	1	16	15	4	1	0	1.72	0.77	0.59	2	0.68
5e	7	4	12	10	4	0	2.47	0.88	0.78	2	(0.26)
5f	4	6	22	5	0	0	1.97	0.58	0.33	2	(0.74)
Question 6											
6a	6	9	16	5	1	0	1.94	0.76	0.58	2	(0.01)
6b	4	6	8	13	6	0	2.58	0.99	0.97	3	(0.42)
6c	8	6	15	7	1	0	2.10	0.76	0.58	2	(0.14)
6d	6	8	14	8	1	0	2.06	0.80	0.64	2	(0.14)
6e	8	7	13	7	2	0	2.14	0.86	0.74	2	0.04
6f	5	6	19	7	0	0	2.03	0.64	0.41	2	(0.59)
6g	6	3	11	13	4	0	2.58	0.83	0.70	3	(0.51)
Question 7											
7a	3	11	15	6	2	0	1.97	0.86	0.73	2	0.22
7b	3	11	20	2	1	0	1.79	0.68	0.46	2	0.12
7c	4	12	19	1	1	0	1.73	0.66	0.44	2	0.17
Question 8											
8a	8	5	12	10	2	0	2.31	0.83	0.70	2	(0.20)
8b	9	4	14	7	3	0	2.32	0.85	0.72	2	(0.04)
8c	9	6	17	4	1	0	2.00	0.71	0.50	2	(0.04)
8d	10	3	19	4	1	0	2.11	0.63	0.40	2	(0.18)
Question 9											
9	10	3	14	9	1	0	2.30	0.70	0.49	2	(0.24)
Question 10											
10a	2	1	13	13	8	0	2.80	0.82	0.67	3	(0.66)
10b	5	1	12	13	5	1	2.78	0.86	0.73	3	(0.48)
10c	3	1	10	19	4	0	2.76	0.69	0.47	3	(1.12)
10d	4	3	17	12	1	0	2.33	0.68	0.46	2	(0.73)

Negotiation Preparation Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	33	4	23	35	5	1	2.65	0.76	0.58	3	(0.14)
Validating	23	3	29	41	5	0	2.62	0.66	0.44	3	(0.60)
Program Est	24	13	37	25	2	0	2.21	0.74	0.55	2	(0.24)
Budgeting	27	14	37	20	3	0	2.16	0.77	0.60	2	(0.05)
ICE	44	6	21	24	6	0	2.53	0.82	0.67	3	0.27
Software	38	10	22	20	11	0	2.51	0.96	0.92	2	0.25
Repair Parts	34	3	17	37	10	0	2.81	0.74	0.54	3	(0.22)
R&D	26	9	22	24	18	2	2.76	1.03	1.06	3	(0.09)
Service	28	4	13	32	23	1	3.05	0.87	0.76	3	(0.37)
Hardware	20	6	27	39	9	0	2.63	0.78	0.60	3	(0.54)
Construction	45	3	16	24	13	0	2.84	0.84	0.71	3	0.22
Commodity	50	1	5	23	21	1	3.31	0.75	0.57	3	0.23
Question 2											
CE	23	15	25	22	14	2	2.53	1.07	1.15	2	0.07
PD&RR	21	13	24	34	8	1	2.50	0.92	0.85	3	(0.21)
E&MD	18	9	34	35	5	0	2.43	0.76	0.58	2	(0.50)
PFD&OS	20	9	26	35	11	0	2.59	0.85	0.72	3	(0.41)
Question 3											
FFP	18	7	27	37	12	0	2.65	0.83	0.69	3	(0.52)
FPE	35	3	17	33	13	0	2.85	0.78	0.61	3	(0.16)
FPIS	37	2	20	36	6	0	2.72	0.67	0.45	3	(0.15)
FPR(P)	32	3	23	36	7	0	2.68	0.71	0.51	3	(0.27)
FPR(R)	34	3	21	33	10	0	2.75	0.76	0.58	3	(0.17)
FPIF	31	2	25	34	9	0	2.71	0.72	0.52	3	(0.28)
CPIF	28	6	22	33	12	0	2.70	0.84	0.70	3	(0.26)
CPAF	28	7	22	33	11	0	2.66	0.85	0.72	3	(0.24)
CPFF	25	8	22	34	12	0	2.66	0.87	0.75	3	(0.30)
T&M	29	4	14	30	23	1	3.04	0.89	0.79	3	(0.32)
Labor Hour	32	3	17	24	24	1	3.04	0.91	0.82	3	(0.19)
Question 4											
Pre-Award	13	9	32	38	9	0	2.53	0.81	0.66	3	(0.58)
Post-Award	19	4	20	27	28	3	3.07	0.96	0.91	3	(0.51)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	16	8	36	30	11	0	2.52	0.83	0.70	2	(0.41)
5b	14	9	41	31	6	0	2.39	0.76	0.58	2	(0.49)
5c	12	20	45	19	5	0	2.10	0.81	0.65	2	(0.10)
5d	15	12	56	14	4	0	2.12	0.69	0.47	2	(0.28)
5e	22	2	15	41	21	0	3.03	0.75	0.56	3	(0.70)
5f	15	7	50	23	6	0	2.33	0.72	0.52	2	(0.41)
Question 6											
6a	22	13	46	16	4	0	2.14	0.74	0.55	2	(0.13)
6b	18	7	25	36	15	0	2.71	0.86	0.74	3	(0.52)
6c	14	12	47	20	8	0	2.28	0.81	0.66	2	(0.20)
6d	18	8	41	26	8	0	2.41	0.79	0.63	2	(0.34)
6e	19	11	35	29	7	0	2.39	0.82	0.68	2	(0.31)
6f	18	17	49	12	5	0	2.06	0.77	0.59	2	(0.03)
6g	19	8	36	29	9	0	2.48	0.81	0.66	2	(0.36)
Question 7											
7a	12	30	50	7	2	0	1.79	0.68	0.46	2	0.00
7b	12	30	53	5	1	0	1.74	0.61	0.37	2	(0.23)
7b	14	31	52	3	1	0	1.70	0.59	0.35	2	(0.23)
Question 8											
8a	16	15	49	14	8	0	2.17	0.82	0.68	2	(0.03)
8b	16	13	52	15	5	0	2.14	0.74	0.54	2	(0.19)
8c	16	25	49	7	5	0	1.91	0.77	0.60	2	0.19
8c	17	15	52	11	6	0	2.10	0.77	0.59	2	(0.04)
Question 9											
9	30	6	37	20	8	0	2.42	0.80	0.63	2	(0.04)
Question 10											
10a	15	3	38	38	7	0	2.57	0.69	0.48	3	(0.73)
10b	21	0	24	43	13	0	2.86	0.67	0.44	3	(0.73)
10c	18	4	26	42	11	0	2.72	0.75	0.56	3	(0.68)
10d	19	13	35	28	6	0	2.33	0.83	0.68	2	(0.27)

Review or Audit Estimates Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	33	6	19	27	15	1	2.79	0.93	0.87	3	(0.04)
Validating	18	9	25	36	10	3	2.67	0.95	0.89	3	(0.27)
Program Est	28	10	28	31	4	0	2.40	0.79	0.62	2	(0.19)
Budgeting	29	9	33	26	4	0	2.35	0.77	0.59	2	(0.14)
ICE	52	8	15	18	8	0	2.53	0.95	0.90	3	0.63
Software	41	11	14	23	10	2	2.63	1.06	1.13	3	0.38
Repair Parts	34	2	16	32	17	0	2.96	0.78	0.61	3	(0.22)
R&D	28	4	16	25	25	3	3.10	0.97	0.94	3	(0.26)
Service	31	2	12	26	30	0	3.20	0.82	0.67	3	(0.37)
Hardware	25	7	29	31	9	0	2.55	0.82	0.67	3	(0.28)
Construction	39	2	17	30	13	0	2.87	0.77	0.60	3	(0.03)
Commodity	52	0	5	24	19	1	3.33	0.68	0.46	3	0.28
Question 2											
CE	27	17	21	19	17	0	2.49	1.07	1.15	2	0.11
PD&RR	22	13	25	32	8	1	2.48	0.93	0.86	3	(0.16)
E&MD	0	6	27	38	5	0	2.55	0.72	0.52	3	(0.46)
PFD&OS	28	5	25	33	10	0	2.66	0.80	0.63	3	(0.27)
Question 3											
FFP	30	6	30	24	11	0	2.56	0.85	0.72	2	(0.08)
FPE	42	3	24	21	11	0	2.68	0.83	0.69	3	0.20
FPIS	43	3	22	25	8	0	2.66	0.78	0.61	3	0.17
FPR(P)	42	3	26	23	7	0	2.58	0.76	0.58	3	0.17
FPR(R)	43	3	23	23	9	0	2.66	0.80	0.64	3	0.20
FPIF	35	5	27	25	9	0	2.58	0.82	0.67	3	0.01
CPIF	33	4	20	32	12	0	2.76	0.81	0.65	3	(0.17)
CPAF	36	5	17	32	11	0	2.75	0.82	0.68	3	(0.07)
CPFF	35	5	15	35	11	0	2.79	0.81	0.65	3	(0.13)
T&M	36	3	9	26	25	2	3.22	0.89	0.78	3	(0.15)
Labor Hour	38	2	10	24	25	2	3.24	0.87	0.75	3	(0.09)
Question 4											
Pre-Award	19	12	35	31	4	0	2.33	0.78	0.61	2	(0.38)
Post-Award	23	3	15	25	28	7	3.27	1.00	0.99	3	(0.43)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	14	11	32	30	14	0	2.54	0.91	0.82	3	(0.37)
5b	12	9	51	24	5	0	2.28	0.72	0.52	2	(0.44)
5c	14	18	47	19	3	0	2.08	0.75	0.56	2	(0.24)
5d	14	17	39	26	5	0	2.22	0.82	0.68	2	(0.25)
5e	24	1	17	38	21	0	3.03	0.74	0.54	3	(0.62)
5f	15	10	48	21	7	0	2.29	0.78	0.60	2	(0.28)
Question 6											
6a	21	12	39	24	5	0	2.28	0.79	0.62	2	(0.22)
6b	16	4	28	37	16	0	2.76	0.81	0.65	3	(0.64)
6c	19	12	40	19	11	0	2.35	0.89	0.79	2	(0.09)
6d	19	14	41	23	4	0	2.21	0.78	0.60	2	(0.24)
6e	20	16	31	29	5	0	2.28	0.85	0.72	2	(0.21)
6f	22	19	41	16	3	0	2.04	0.77	0.59	2	(0.03)
6g	23	7	29	33	9	0	2.56	0.81	0.66	3	(0.36)
Question 7											
7a	14	36	42	6	3	0	1.72	0.74	0.54	2	0.33
7b	14	32	50	4	1	0	1.70	0.61	0.37	2	(0.16)
7c	16	36	45	3	1	0	1.64	0.61	0.37	2	(0.03)
Question 8											
8a	20	17	35	18	11	0	2.28	0.95	0.89	2	0.04
8b	21	20	31	19	10	0	2.24	0.96	0.93	2	0.10
8c	17	26	43	10	5	0	1.93	0.81	0.66	2	0.21
8e	18	17	49	13	4	0	2.05	0.74	0.55	2	(0.09)
Question 9											
9	33	9	36	18	4	1	2.29	0.82	0.68	2	0.18
Question 10											
10a	17	5	40	30	9	0	2.51	0.76	0.58	2	(0.48)
10b	26	1	18	46	9	1	2.88	0.67	0.45	3	(0.55)
10c	19	4	28	40	9	1	2.70	0.78	0.60	3	(0.54)
10d	20	8	37	29	6	1	2.44	0.82	0.67	2	(0.26)

Set Corporate Policy Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variance	Median	Skew
Question 1											
Benchmarking	0	3	2	0	0	0	1.40	0.49	0.24	1	0.61
Validating	0	2	3	0	0	0	1.60	0.49	0.24	2	(0.61)
Program Est	0	3	1	1	0	0	1.60	0.80	0.64	1	1.26
Budgeting	0	2	3	0	0	0	1.60	0.49	0.24	2	(0.61)
ICE	1	2	0	2	0	0	2.00	1.00	1.00	2	0.17
Software	0	3	1	1	0	0	1.60	0.80	0.64	1	1.26
Repair Parts	1	2	1	0	2	0	2.40	1.30	1.69	3	(0.05)
R&D	1	1	1	1	1	0	2.50	1.12	1.25	3	0.00
Service	1	0	0	3	1	0	3.25	0.43	0.19	3	(1.75)
Hardware	1	2	0	1	1	0	2.25	1.30	1.69	2	0.52
Construction	0	1	0	2	2	0	3.00	1.10	1.20	3	(1.36)
Commodity	1	0	0	2	2	0	3.50	0.50	0.25	4	(1.74)
Question 2											
CE	0	4	1	0	0	0	1.20	0.40	0.16	1	2.24
PD&RR	0	3	2	0	0	0	1.40	0.49	0.24	1	0.61
E&MD	0	2	2	1	0	0	1.80	0.75	0.56	2	0.51
PFD&OS	0	2	2	1	0	0	1.80	0.80	0.64	2	0.05
Question 3											
FFP	1	1	1	2	0	0	2.25	0.83	0.69	3	(0.54)
FPE	2	1	2	1	0	0	2.00	0.82	0.67	2	0.54
FPIS	2	1	1	1	0	0	2.00	0.82	0.67	2	0.54
FPR(P)	2	1	1	1	0	0	2.00	0.82	0.67	2	0.54
FPR(R)	2	1	1	1	0	0	2.00	0.82	0.67	2	0.54
FPIF	2	1	1	1	0	0	2.00	0.82	0.67	2	0.54
CPIF	2	2	0	1	0	0	1.67	0.94	0.89	1	1.36
CPAF	2	2	0	1	0	0	1.67	0.94	0.89	1	1.36
CPFF	2	2	0	1	0	0	1.67	0.94	0.89	1	1.36
T&M	2	2	0	1	0	0	1.67	0.94	0.89	1	1.36
Labor Hour	3	0	0	2	0	0	3.00	0.00	0.00	3	0.61
Question 4											
Pre-Award	0	2	3	0	0	0	1.60	0.49	0.24	2	(0.61)
Post-Award	0	1	3	1	0	0	2.00	0.63	0.40	2	0.00

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variance	Median	Skew
5a	0	3	2	0	0	0	1.40	0.49	0.24	1	0.61
5b	0	3	2	0	0	0	1.40	0.49	0.24	1	0.61
5c	0	4	1	0	0	0	1.20	0.40	0.16	1	2.24
5d	0	4	1	0	0	0	1.20	0.40	0.16	1	2.24
5e	2	0	2	1	0	0	2.33	0.47	0.22	2	(0.17)
5f	1	3	1	0	0	0	1.25	0.43	0.19	1	0.00
Question 6											
6a	1	3	2	0	0	0	1.40	0.43	0.19	1	0.00
6b	0	2	1	1	1	0	2.20	1.17	1.36	2	0.54
6c	0	2	2	1	0	0	1.80	0.75	0.56	2	0.51
6d	0	3	1	1	0	0	1.60	0.80	0.64	1	1.26
6e	0	3	1	1	0	0	1.60	0.80	0.64	1	1.26
6f	0	2	2	1	0	0	1.80	0.75	0.56	2	0.51
6g	1	1	2	1	0	0	2.00	0.83	0.69	3	(0.54)
Question 7											
7a	0	2	1	2	0	0	2.00	0.89	0.80	2	0.00
7c	1	3	2	0	0	0	1.40	0.43	0.24	1	0.61
7c	1	3	1	0	0	0	1.25	0.43	0.19	1	0.00
Question 8											
8a	0	1	3	0	1	0	2.20	0.98	0.96	2	1.29
8b	1	1	2	0	1	0	2.25	1.09	1.19	2	0.55
8b	1	2	3	0	0	0	1.60	0.43	0.19	2	(1.26)
8d	1	0	3	1	0	0	2.25	0.43	0.19	2	(1.29)
Question 9											
9	1	0	3	1	0	0	2.25	0.43	0.19	2	(1.29)
Question 10											
10a	0	0	4	1	0	0	2.20	0.40	0.16	2	2.24
10b	0	0	3	2	0	0	2.40	0.49	0.24	2	0.61
10c	0	1	1	3	0	0	2.40	0.80	0.64	3	(1.26)
10d	1	1	3	0	0	0	1.75	0.43	0.19	2	(1.26)

Federal Government Policy Group Data

	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
Question 1											
Benchmarking	8	2	10	6	2	0	2.40	0.80	0.64	2	(0.08)
Validating	6	3	8	7	4	0	2.55	0.94	0.88	3	(0.19)
Program Est	4	7	9	7	1	0	2.08	0.86	0.74	2	(0.08)
Budgeting	5	5	9	8	1	0	2.22	0.83	0.69	2	(0.24)
ICE	11	6	6	3	2	0	2.06	1.00	1.00	2	0.71
Software	6	4	6	7	4	1	2.64	1.11	1.23	3	0.01
Repair Parts	7	0	4	12	5	0	3.05	0.65	0.43	3	(0.69)
R&D	7	1	5	8	5	2	3.10	1.02	1.04	3	(0.23)
Service	5	1	6	9	7	0	2.96	0.86	0.74	3	(0.67)
Hardware	3	3	7	12	3	0	2.60	0.85	0.72	3	(0.69)
Construction	5	0	8	11	4	0	2.83	0.70	0.49	3	(0.77)
Commodity	11	0	2	7	8	0	3.35	0.68	0.46	3	(0.19)
Question 2											
CE	4	6	6	8	4	0	2.42	1.04	1.08	3	(0.14)
PD&RR	4	3	11	7	3	0	2.42	0.86	0.74	2	(0.29)
E&MD	4	2	12	8	2	0	2.42	0.76	0.58	2	(0.49)
PFD&OS	3	2	11	7	5	0	2.60	0.89	0.80	2	(0.40)
Question 3											
FFP	5	2	9	9	3	0	2.57	0.82	0.68	3	(0.46)
FPE	7	0	7	11	3	0	2.81	0.66	0.44	3	(0.58)
FPIS	6	1	8	10	3	0	2.68	0.76	0.58	3	(0.53)
FPR(P)	6	1	7	11	3	0	2.73	0.75	0.56	3	(0.59)
FPR(R)	6	1	8	10	3	0	2.68	0.76	0.58	3	(0.53)
FPIF	6	0	10	9	3	0	2.68	0.70	0.49	3	(0.55)
CPIF	6	2	6	10	4	0	2.73	0.86	0.74	3	(0.46)
CPAF	7	2	7	8	3	1	2.71	0.98	0.97	3	(0.07)
CPFF	7	2	7	8	3	1	2.71	0.98	0.97	3	(0.07)
T&M	6	0	2	13	6	1	3.27	0.69	0.47	3	(0.82)
Labor Hour	6	0	3	10	8	1	3.32	0.76	0.58	3	(0.76)
Question 4											
Pre-Award	4	6	9	9	0	0	2.13	0.78	0.61	2	(0.43)
Post-Award	5	1	6	11	5	0	2.87	0.80	0.64	3	(0.72)

Question 5	No Response	# 1	# 2	# 3	# 4	# 5	Mean	Std Dev	Variation	Median	Skew
5a	2	3	10	9	4	0	2.54	0.89	0.79	3	(0.42)
5b	3	1	13	8	3	0	2.52	0.75	0.57	2	(0.54)
5c	2	7	14	3	2	0	2.00	0.83	0.69	2	0.30
5d	3	5	13	5	2	0	2.16	0.83	0.69	2	(0.05)
5e	5	1	7	10	5	0	2.83	0.82	0.67	3	(0.64)
5f	5	3	14	4	2	0	2.22	0.78	0.60	2	(0.13)
Question 6											
6a	4	4	14	5	1	0	2.13	0.73	0.53	2	(0.29)
6b	5	1	9	9	4	0	2.70	0.80	0.65	3	(0.54)
6c	2	3	12	9	2	0	2.38	0.79	0.62	2	(0.46)
6d	3	2	11	8	4	0	2.56	0.85	0.73	2	(0.45)
6e	2	3	11	8	4	0	2.50	0.89	0.79	2	(0.33)
6f	3	7	15	2	1	0	1.88	0.71	0.51	2	0.07
6g	4	1	11	9	3	0	2.58	0.76	0.58	3	(0.60)
Question 7											
7a	3	9	12	3	1	0	1.84	0.78	0.61	2	0.25
7b	2	9	14	2	1	0	1.81	0.73	0.54	2	0.33
7c	3	10	13	1	1	0	1.72	0.72	0.52	2	0.41
Question 8											
8a	3	2	19	2	2	0	2.16	0.67	0.45	2	(0.14)
8b	2	1	20	2	3	0	2.27	0.71	0.50	2	0.09
8c	2	5	18	2	1	0	1.96	0.65	0.42	2	(0.08)
8d	3	2	17	5	1	0	2.20	0.63	0.40	2	(0.54)
Question 9											
9	8	2	11	4	2	1	2.45	0.97	0.95	2	0.31
Question 10											
10a	4	1	13	8	2	0	2.46	0.71	0.50	2	(0.59)
10b	4	0	7	11	5	1	3.00	0.82	0.67	3	(0.69)
10c	4	0	9	6	8	1	3.04	0.93	0.87	3	(0.54)
10d	6	4	6	9	2	1	2.55	1.03	1.07	3	0.00

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